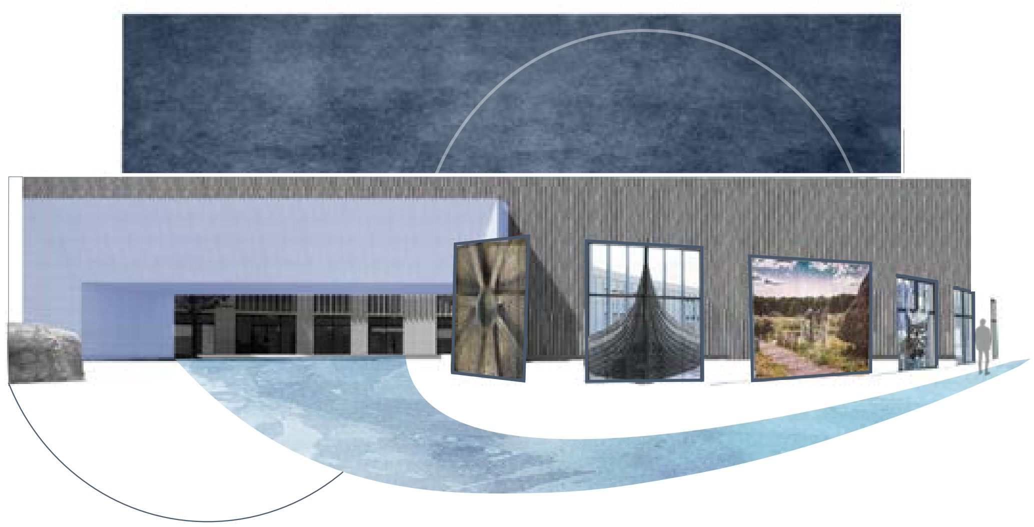

THE NEW VIKING SHIP MUSEUM IN ROSKILDE

MASTER´S THESIS | MAY 2023
THE NEW VIKING SHIP MUSEUM IN ROSKILDE

MSc04-ARC21 | ARCHITECTURE, AAU
ALEXANDER WINTHER RØNNEST, LINE BUNDGAARD JENSEN & TIBA ADNAN

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MASTER´S THESIS

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Engineering Focus: Indoor Environment & Sustainability

Supervisor: Michael Lauring
Technical Supervisor: Anna Marszal-Pomianowska

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LINE BUNDGAARD JENSEN

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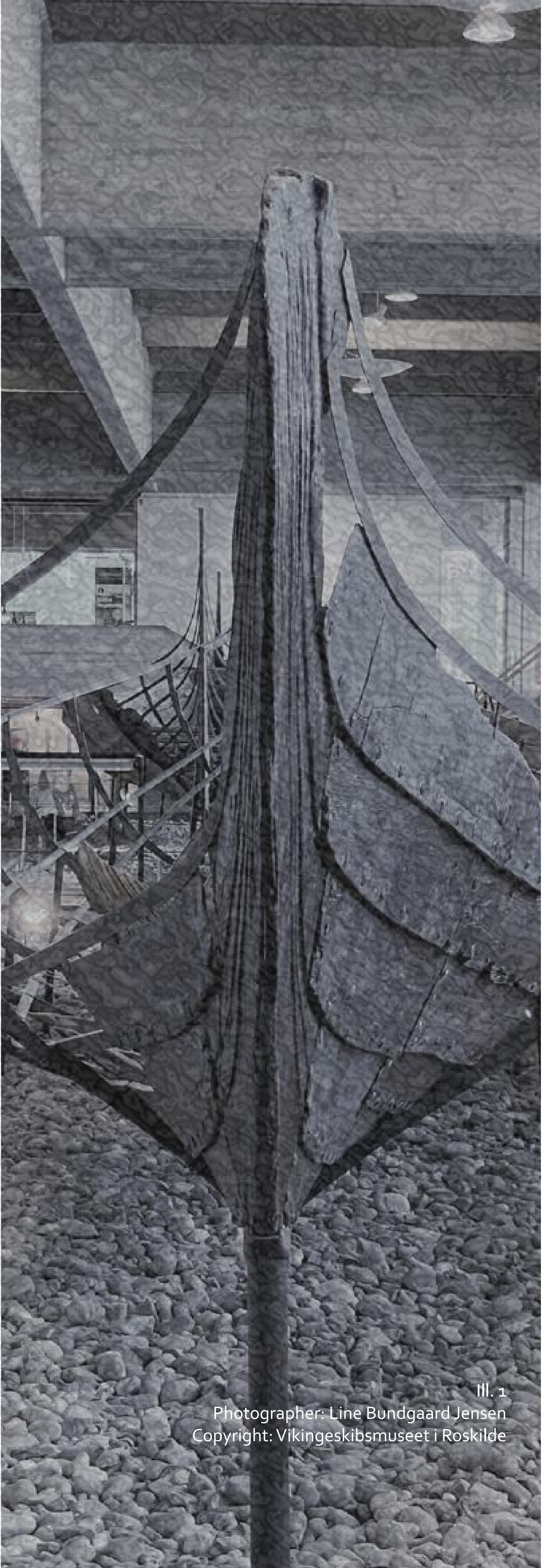


Ill. 1
Photographer: Line Bundgaard Jensen

ABSTRACT

This project presents a proposal for a new Viking Ship Museum in Roskilde, designed with focus on an immersive and educational experience that showcases Viking history, culture, and maritime heritage. This will be achieved through an inviting and aesthetically pleasing architecture of the new Museum, where the interior layout and indoor climate control, as well as comfort, will be taken into consideration.

The paper examines in-depth indoor climate conditions such as lighting, illumination hours, ventilation and temperature to ensure the preservation of the artifacts. Furthermore, examinations about load-bearing structural systems and Life Cycle Assessment regarding the choice of materials are included to make the project as ecologically sustainable as possible.

Lastly, indoor and outdoor activities will be integrated as well as acoustic, atmospheric, thermal, and visual comfort in the exhibition areas to ensure comfort and a well-rounded and engaging experience for the visitors.

The result is the New Viking Ship museum; A museum that ensures the visitors´ comfort and provides interactive and engaging experiences through spatial layout, placement of functions, and materials. Likewise, thermal, acoustic, and visual comfort is attained as well as a structural system that ensures safety and structural integrity.


Ill. 2
Photographer: Tiba Adnan

READING GUIDE

The following Master Thesis consists of a Program, a Design Process and a Presentation, in which the final proposal for the New Viking Ship Museum in Roskilde will be presented. The chosen methodology is The Integrated Design Process, which makes the project an iterative process, of which acquired knowledge throughout the different analyses and studies will be reflected upon and further developed during the design process. The Program sets the framework for which the design process is based on, including different theories, analysis and preliminary research. Lastly, the final proposal will be presented through diagrams, plans, sections, elevations and visualizations to communicate the atmospheric experiences of the design.

The appendix will contain supporting content of the thesis, and will be referred to throughout the report. References are listed after the Harvard-reference method, and can be found in the epilogue of the report, alongside a list of the illustrations used. Illustrations made by the students will be listed only by number, as no sources have been used.

PREFACE

The Viking Ship Museum possesses valuable artifacts; five original viking ships that were excavated outside of Skuldelev in Roskilde Fjord. Due to inadequacies in the current building, the Museum is now expanding with new buildings and new exhibition halls for the ships. This process has been published as an architectural competition that includes construction of a new hall for the viking ships and a new welcoming building, as well as a transformation of the current viking ship hall.

Five architectural teams will each contribute with their proposal, based on a detailed and informative competition brief. Due to it being a closed competition, this brief has not been publicly accessible, and the needed information has been sought out by the group itself. The competition will instead act as a base for the following project, as it can not follow the brief strictly.

This project will keep its focus on the new museum construction, and not the transformation of the current viking ship hall, which will only be mentioned on a conceptual plan.

Ill. 3
Photographer: Line Bundgaard Jensen

TABLE OF CONTENT

01. INTRODUCTION

Ill. 4
Photographer: Tiba Adnan

MOTIVATION

The Viking Age is a crucial part of Scandinavian history being highly valued by many. The most important and defining symbol of the Viking Age is the ship, which laid the bedrock for the evolution of Danish society expanding the territory to include both England and Norway. Through settlements and raiding of the Anglo-Saxon area, the Danish trading economy and market greatly improved. The ships allowed for the Danes to possess a more international focus marking them as a prominent european power at the time (Roesdahl, 2022; natmus.dk, n.d.).

As the naval capabilities and the huge impact the vikings have had, the development of Denmark as a nation can be characterized by the Viking Ship. Their importance of this time period is evident and indicates the significance of preserving the remains as both a symbol of a defining period in Danish history and an important artifact to gain knowledge of the past. The Viking Ship Museum in Roskilde currently exhibits one of the greatest finds in history; the five original viking ships from Skuldelev. The building can, however, no longer protect the important ships, as they are threatened by climate change and rising water levels. The ships are in desperate need of being transferred to a new building that can sustain the unpredictable weather and preserve them for many years forward; thus, a new exhibition hall is required (appendix 1).

ARCHITECTURE & ART

MUSEUM HISTORY

Architecture and art have been strongly connected through history ever since the first cave paintings, temples and churches to the development of the museums, and more specifically, the explosions of art museums in the 20th and 21st century, where artistic currents brought out new types of museums (Mandahl, 2016).

THE FIRST COLLECTIONS

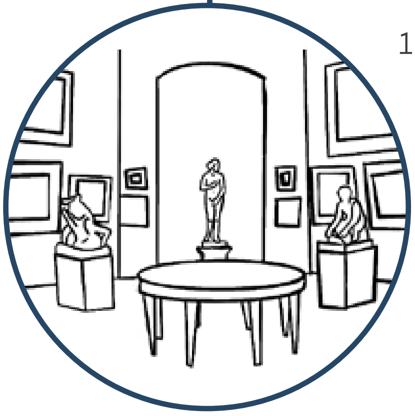
The first private collections were established, in the European Medieval Ages, by kings, nobles, wealthy merchants, or religious institutions, as they were collecting images and artifacts that would only be displayed in special rooms under private affairs or at representative occasions. Large art collections at powerful families didn't occur until the Renaissance, where a collection as such would be referred to as a "museum" – originated from the Greek word "museion", which means the protector of art. In the 18th century, many of these private collections turned into public exhibitions, where the first building built for showing private collections to the public was in 1683.

THE FIRST PUBLIC MUSEUMS

A new interest and the increasing trade and flourishing industrialization became the foundation of two of Europe's most significant museums; British Museum from 1759 and Louvre from 1793. In the 19th century, the culture-, nature- and art museums became a central part in creating the European national states and brought a national identity to these.

This became the groundwork for monumental museums all over Europe that sought to showcase the nations' grandeur and splendor. The museums face the public with monumental stairs and richly decorated halls illuminated by the daylight from above, such as the British Museum and Louvre. The architectural expression became an example of the art collections and the events of the time.

THE FIRST PUBLIC EXHIBITIONS

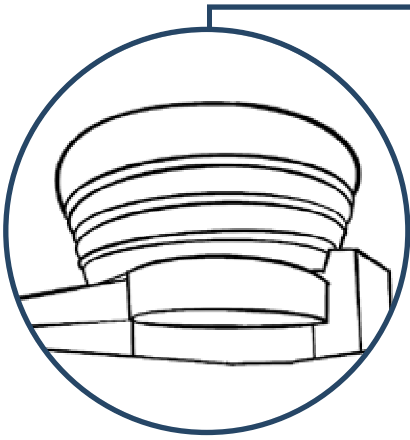


18TH CE.

LOUVRE MUSEUM

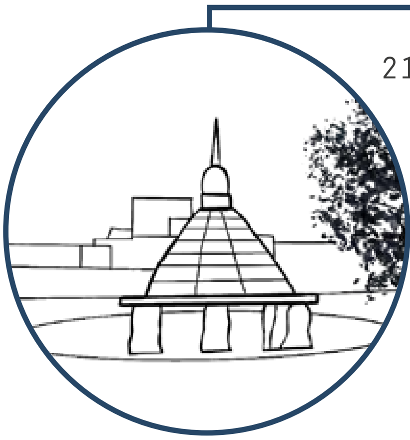
1793

GUGGENHEIM, NEW YORK



1937

SCULPTURE PARK, KUNSTEN



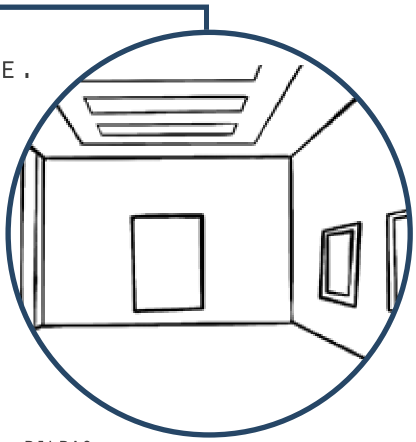
21ST CE.

The british museum

1759

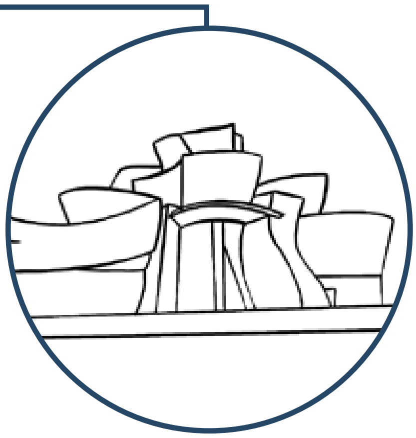
The white cube

19th ce.



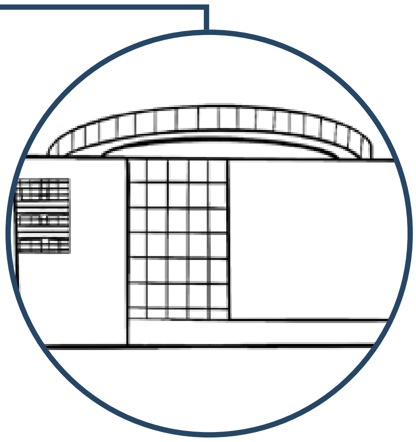
Guggenheim, Bilbao

1997



Aros, Rainbow Panorama

2011



Ill. 5, museum development

THE MODERN MUSEUM; WHITE CUBE

Towards the late 19th century, a new abstract art was noticed and so was Modernism that challenged the artistic traditions and established museum institutions. The modern museum should allow for the art to be the center without the representation's obligations. The white cube was born, where the modern museum was shaped as neutral, rectangular rooms with white walls, indirect lighting, well-lit sculptures, a proper distance between the artworks and a discrete signage. The Guggenheim Museum in New York is a great example of the white cube architecture, shaped in a circular form, with the art centered in neutral spaces. The white cube architecture became a temple for the art, where all educational aspects and historical perspective is gone.

EXPRESSIONISM AND NEW TENDENCIES

The Guggenheim Museum in Bilbao became a landmark for the city and made the city noticeable in the world, due to the expressionist architecture and sculptural shapes. This successful museum became an inspiration worldwide, where the architectural expression is notable and spectacular with the purpose of attracting attention to brand a city or a region. This expressionistic tendency provokes the modern white cube and discusses the relation between art and architecture as well as how the architecture becomes the artwork.

The newest tendencies explore the concept of moving the artwork out into public areas, such as the Sculpture Park at Kunsten, Aalborg, at festivals or in private homes as a rebellion to the museum within closed walls. Other concepts try to tie the art together with the architecture to dissolve the distinction between the architectural and the artistic space, as Aros Museum does with the artwork "Your Rainbow Panorama". Art and architecture are a topic always with new possibilities of exploring and interpreting the relationship between the two.

METHODOLOGY

THE INTEGRATED DESIGN PROCESS

The following consists of the methodologies and overall approaches utilized in the creation of the new viking museum. Methodology is defined as a handful of methods, rules and postulates employed by a discipline. The Integrated Design Process and Sub-Methodologies are the chosen methodology for this paper.

During the studies of Architecture and Design at Aalborg University, the Integrated Design Process (IDP) has been primarily utilized as a method. This is because the IDP ensures a holistic design approach, where it aims to ensure the integration of knowledge from engineering, sustainability and architecture in order to address the problems connected to the design of the building (Knudstrup, 2005).

By combining both the engineering and architectural knowledge the complex design problems get solved. Therefore there different areas such as occupancy, indoor comfort and the implementation of sustainable strategies, energy consumption, and construction will be investigated through five phases: The problem/idea, then analysis, then sketching, then synthesis, and lastly the presentation phase. These five phases are an iterative process where various loops can be made during the project. Different tools have been utilized during these different phases to provide a better understanding and insight into the project.

"... an architect ought to be able to accomplish much more in all the arts and sciences than the men who, by their own particular kinds of work and the practice of, have brought every single subject to the highest perfection" (Vitruvius, 1914, p. 11)

PROBLEM

This is the starting point for describing the problem or the idea which will be investigated through research-based information. Articles, reports, requirements from the Viking Ship Museum, documentaries, interviews, and field observations will eventually form the problem which the project aims to address.

ANALYSIS

This phase revolves around gathering and analyzing information, data and knowledge based on both field and desktop studies. It will in that sense take the initial problem even further. This is achieved by gathering information about the site, microclimatic conditions and general sense of place. In addition to that, focus on the user group and the competition organizer , their demands for space, functionality, logistics and architectural qualities.

Furthermore, supplemental, relevant theoretical research will be utilized in combination with the analyses conducted. The result of all of these analyses will be communicated through design criterias.

SKETCHING

Phase three revolves around different investigations to create the sub-conclusions from the analysis phase, in that way combining the architectural and engineering knowledge gathered in the two previous phases.

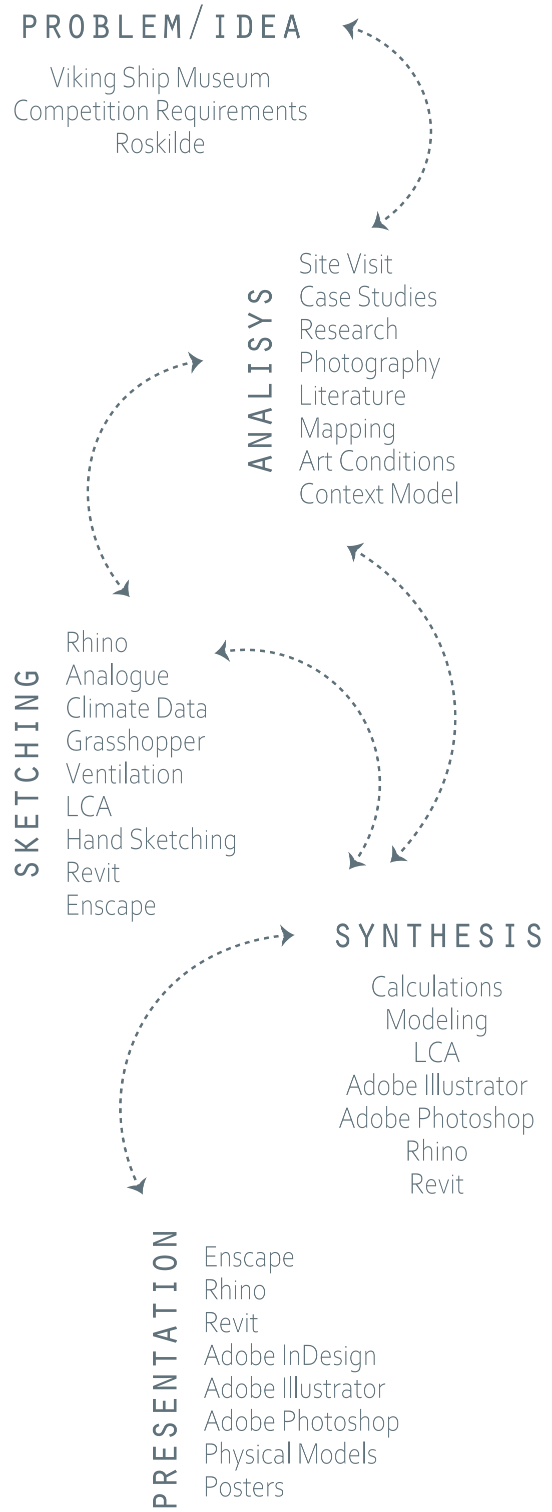
Furthermore, initial design criteria and room program will be accomplished at this phase. Both the architectural design and the environmental impact of the museum such as functions, construction, daylight and energy is documented and visualized through this phase. Different physical models, sketches, hand calculations, computer software and simulations will be utilized to compare and discuss different design proposals. This approach ensures that the outcome is both evaluated on architectural and engineering qualities.

SYNTHESIS

Phase four gathers all the elements from the previous phases, concerning functional, technical, and aesthetical aspects. Here the project's form is getting closer to be final and complies with the concept, room program, and design criteria. This means that it is a point in the process where all parameters from the sketching phase will be optimized and documented through calculations and simulations.

PRESENTATION

Lastly is the presentation phase, where the final design proposal will be built physically and in 3D softwares to show the detailed qualities of the design such as spatial visualizations, technical drawings, renders for the atmospheric experience and the project's diagrams, to gain a better understanding of the New Viking Ship Museum's relation to both the city, the landscape and to the user.



Ill. 6, the integrated design process

SUB-METHODS

	WHAT	WHY	HOW
MAPPING 	Utilized in the early stages of the project to describe the preconditions of the context by analyzing the microclimate and infrastructure.	To gain a better understanding of the surrounding area and thereby utilizing the contextual preconditions in a beneficial way.	Visualized through diagrams, maps and describing text to supplement and explain the surrounding context.
STROLLOGY 	A visual and phenomenological approach that consists of several pictures, shown along with a map presenting the routes and the viewpoints.	To get an understanding of the atmosphere when approaching the site from different sides and to get a sense of place.	Selecting routes to show the experience of space, atmosphere and contrasts by interpreting the distinctive characteristics through photography.
INTERVIEW 	An interview consists of a series of prepared questions that are discussed in a formal conversation between the interviewer and the respondent.	Direct contact with the project manager gives a better understanding of the requirements and wishes, which is essential knowledge for the project design.	By engaging in a conversation with the head leader of the project to gain knowledge about the requirements for the project subject and general information needed.
PERSONA 	Fictive characters who are created based on empirical data from the information meeting that the museum arranged for the public community.	To create a reliable and realistic representation of physical characteristics that define the visitors of the museum.	By making a detailed description of a character through needs, ideas, visions and wishes.

WHAT	WHY	HOW	
Life Cycle Assessment provides an understanding on how different materials' CO_2 emissions affect the environment, while Be18 calculates the energy consumption.	To ensure that the new museum does not have a damaging impact on the environment and that the energy consumption comply with the requirements.	By investigating materials and the load-bearing structure through calculations in LCAbyg and by utilizing Be18 for energy calculations.	CALCULATIONS
Visualizations provides a visual representation of the design and helps in giving an overview of how ideas functions visually.	To give a realistic idea of how the project relates to its surroundings, which ensures an understanding of the project from the process to the final design.	Through diagrams and technical drawings based on 3D models, and through renderings performed in Enscape.	VISUALIZATIONS
Utilizing different plug-ins as a tool to analyze and simulate the sun- and daylight conditions, acoustics and utilizing Bsim for general indoor climate.	To ensure an optimal indoor environment for the visitors and to preserve the artifacts in the museum in terms of light and thermal comfort.	By making scripts in Grasshopper and simulation models through Bsim to analyze and interpret the results.	SIMULATIONS
Physical and 3D-modeling is utilized in order to study different concepts and ideas through computer softwares and foam models.	To investigate shapes, spaces and relations to the context to understand the possibilities and limitations and to develop the spatial layout of the design.	By using 3D-modeling softwares such as Rhino and Revit and by making foam and cardboard models.	MODELING

Ill. 7, sub-methods

SUSTAINABILITY

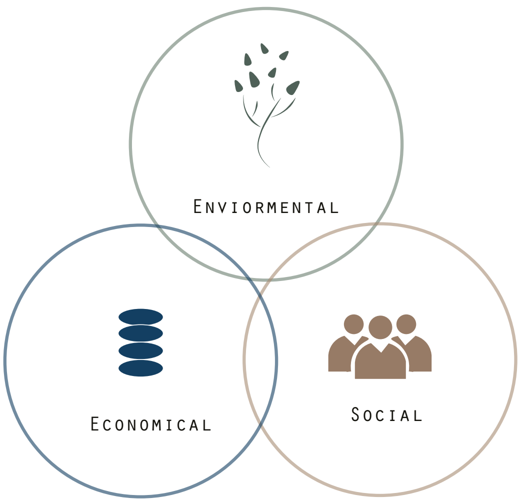
SUSTAINABLE ARCHITECTURE

As climate changes have significantly increased it is required to find alternative solutions to accommodate increasing demands in all sectors of society. The building industry serves as the largest contributor to pollution resulting in further restrictions to minimize this impact emphasizing on the term sustainability.

The chosen theoretical and analytic approach to sustainability as a definition is based on the Brundtland Report that has elucidated the term sustainability by dividing it into three segments: social, environmental, and economic sustainability (WCED, 1987). To ensure a sustainable design proposal this project will have an increased focus upon Life Cycle Assessment of the building materials, and indoor climatic optimization by passive and active strategies.

SOCIAL SUSTAINABILITY

This term is usually considered as a comprehensive term dealing with humans, their interaction, well-being, and health. The reasoning behind the ambiguity of social sustainability is attributable to the fact that most of the elements are qualitative (Energistyrelsen, 2015), however certain quantitative measures have been nationally determined to create the frame for architectural designs.



Ill. 8, sustainability

As the focus, the indoor climatic investigations will contribute to making the architecture and its environments supporting human well-being as well as ensuring that the building obtains the specific indoor climatic demands required throughout the design. This includes air humidity, air change, illumination, and temperature of which all must be obtained to create the optimal surroundings of the main exhibition.

Throughout the process various strategies will be tested. The passive strategies will be utilized to reduce the additional heating demands, lowering energy consumption and moreover to ensure thermal comfort for the visitors. Strategies such as natural ventilation, natural light, and passive heating solutions through materials of high heat capacity will all contribute to form the design and create an optimal human environment.

Active strategies will play another part in terms of design. As the museum has specific requirements to preserve the cultural heritage artifacts, the active strategies such as mechanical ventilation, temperature control, and humidity control will all determine the final form and narration in an exhibiting sense.

ENVIRONMENTAL SUSTAINABILITY

Sustainability in an environmental sense will be

achieved by ensuring a low climate impact.
This is possible by lowering the carbon emissions of the design, both in sense of the materials and structure, and use of the building. In short, this approach is ensured by preserving natural resources along with lowering the impact on the climate in all phases of its lifespan (Energistyrelsen, 2015).

The right material use can be determined through investigations of Life Cycle Assessments, LCA. During construction and demolition, the life cycle assessment of every building material can be utilized. These materials each provide pollution to the project as well.

Their life cycle spans further than their usage as cladding, insulation, or structural elements. In the assessment their production values as well as transport must be considered. These phases each contribute to pollution as well and must be included as the Life Cycle Assessment illustrates the potential deviated consequences of choosing certain materials providing the foundation for valid material choices considering each material's global warming potential concerning the demand for energy consumption determining the true sustainability of the project.

Throughout the project, Life Cycle Assessments will be implemented in aspects of the design process providing a definite value to the consequence of each material choice throughout the architecture spanning from the structural design to the atmospheric experience of space as well as forming a proposition of a sustainable, low-energy, contemporary Viking Ship Museum expansion.

In terms of indoor climatic influence, the environmental sustainability will be expressed by low-energy solutions. By using passive strategies, the energy consumption will be reduced ensuring a low climate impact. Implementing solar panels and other renewable energy sources additionally aids the energy frame of the design making sure that the building will contribute to green power solutions effectively improving upon the sustainable image.

ECONOMICAL SUSTAINABILITY

The economical aspect of sustainability during the process is influenced by LCA in the long term. By being aware of certain materials' duration and reusable qualities, the design will appear more economically efficient. This is also the case in using already recycled materials if their durability and costs are sufficient.

The indoor climate and optimization hereof, impacts the overall energy consumption of the design. By utilizing passive strategies, the need of using power for cooling in the summer, and heating in the summer, using active strategies, can be reduced greatly. These passive strategies can be complemented by renewable energy sources in the act of obtaining an economical sustainable design proposal of a New Viking Ship Museum.

As a conclusion, different approaches can be used in the project, such as utilizing LCA as a method to determine materials used in the project and choosing materials influenced by quality. Implementing passive and active strategies lowers the energy consumption, while different softwares aids in ensuring a healthy indoor environment. Designing bigger spaces for the Viking Ships provides more flexibility to the museum, while adapting the building to different needs during different seasons helps keep the museum vivid. Creating coherence between the landscape, the Museum Island and the existing museum makes for an adaptable and context related building design.

02.
SITE

ROSKILDE CITY

The excavation of the Viking Ships in Roskilde Fjord in 1950 have brought the ships, the Museum and Roskilde together, and made the Viking Ship Museum a part of the DNA of Roskilde. As the ships are owned by the National Museum, it has been decided that the ships must not be moved more than 500 meters, in order to minimize the risk of damages. This means that the new museum should be located at the harbor of Roskilde, as the existing museum is today. The harbor of Roskilde is one of the most important places in the city, as it is a place where citizens, visitors and users of the harbor meets, and where the active community fills the harbor with boats, kayaks, fishermen and winter swimmers, which is both an active offer and an attraction (Roskilde Kommune, 2019).

The Viking Ship Museum contributes with sailings for the museum visitors, working workshops on the Museum Island, and an cultural atmosphere for the visitors across the world, branding Roskilde, and especially the harbor, as an attraction worth experiencing. The harbor is seen as a vivid and diverse district, which are qualities that contribute to an experiential and attractive museum and environment, maintaining the current atmosphere of the harbor area.

Ill. 9
Photographer: Line Bundgaard Jensen

Ill. 10, location of Roskilde

Ill. 11, project site

PROJECT SITE

The project site covers the entire area from the existing museum to the parking space in the west, which makes the building site in close contact to the existing Viking Ship Museum facilities and to the fjord. The site in the east is currently in use by the museum as a place to store the reconstructed ships during winter, and by the public as a place to relax, enjoy the close connection to the fjord and where numerous activities occur, such as a viking market and different gatherings.

The close context of the site includes a treeline towards the south and south-east, formed by the southern main road. The museum area follows the site towards north and west, where the new museum placement, the Museum Island and the Viking Ship Hall acts as the boundaries of the site.

As a part of the outskirts of the city center, the site is surrounded by numerous activities and cultural institutions, such as schools, city parks, stores, galleries and Roskilde Cathedral as the main attraction. The harbor contributes to an active and vivid environment, attracting the public and the tourists visiting the town. Along with the activities of the existing museum, the site becomes a well visited area and a place where many pass by, making it a noticeable site with a great number of possibilities.

Ill. 12, topography sections

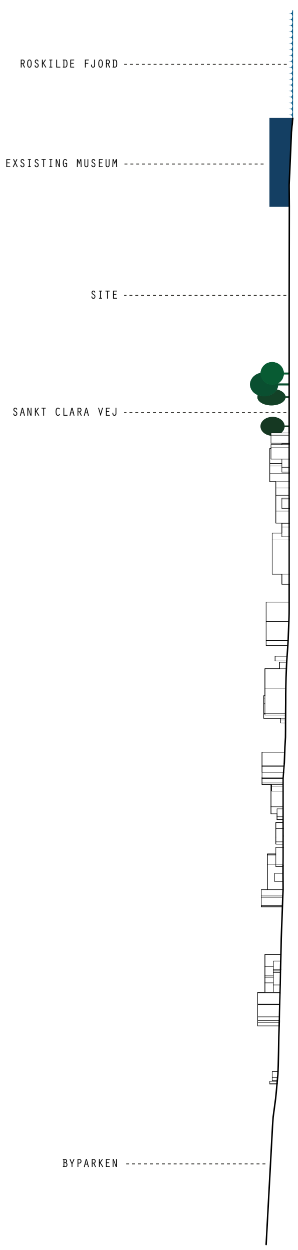
TOPOGRAPHY

Studying the topographic characteristics of the contexts provides an articulate narrative of the placement of the site. Looking at the terrain in a North-South - going direction, it is worth noting that the site is situated at the bottom of a sloping residential area next to the fjord delimited by the existing museum to the east and the museum isalnd to the north.

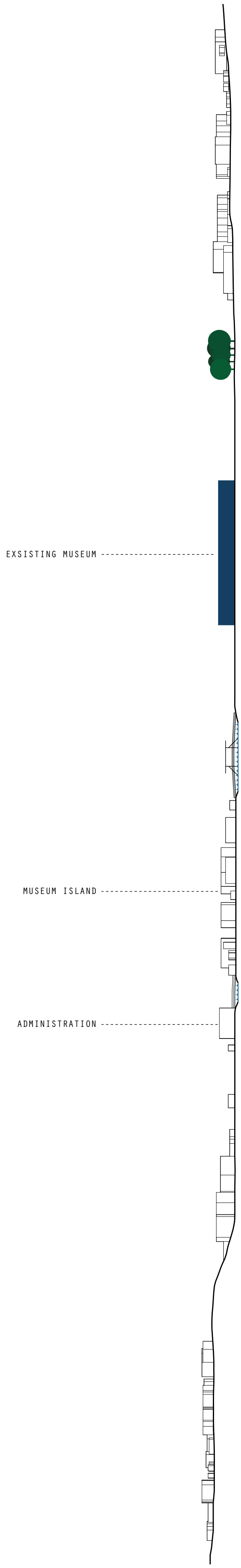
Looking in the span of East-West, the site is delimited by the trees towards east, making a clear indication of the museum area and the residential context. Towards West, the museum island serves as the close context as of which the design must relate. This island marks the border of the museum facilities towards the West from a visitor experience point of view with the administration overlooking the area. Further West, the topography becomes more apparent with a significant slope dividing the harbor area next to the administration building and the residential context uphill.

The new museum complex will be placed in a context in which it must communicate with several actors. The sloping topography from the South will lead heavy flows of water down to the site and with the channels surrounding the museum island, water risings will have a large impact.

The new museum complex must relate to the low residential context as well as the existing museum facilities to integrate the design into the already established surroundings.



Ill. 13, section AA



Ill. 14, section BB

Ill. 15, rising sea water at level 2.5 m

RISING SEA WATER

Flooding is one of the most challenging aspects in this project. Based on the interview (appendix 1) and the history of the site, the flooding is often caused by the nearby harbor. To take a closer look at the water circumstances within the site and around it, a water rising analysis is therefore made. This analysis helps investigate where the problems with floods are obtained.

Therefore, this analysis can be utilized as a base for developing and planning new knowledge and routines to fit local conditions. To accommodate the rising water levels, new construction on the site must be projected for a water level at elevation +2.53 meters DVR90, which is the predicted water level to occur during a storm surge event with a 250 year return period (appendix 1).

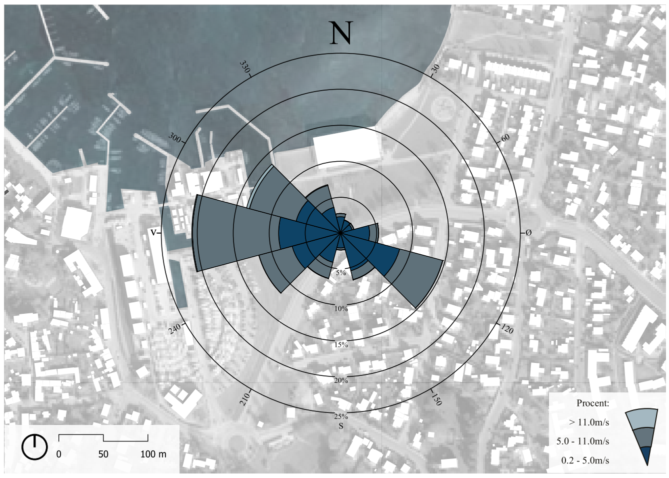
The gained knowledge will be integrated during the early stages of the design process. As seen in the map, the risk for water rise is very high within the site and therefore different strategies will be invistigated throughout the design process.

Some relevant strategies to implement could be LAR-solutions, building the structure above the flood level to minimize damage if a flood does occur or to choose flood resistant materials and place service equipment above the flood level to protect it. Placing a permanent barrier around the structure could also be a strategy, as well as installing sewer backflow valves to prevent flooded sewage systems from backing up into the museum.

WIND

MICROCLIMATIC ANALYSIS

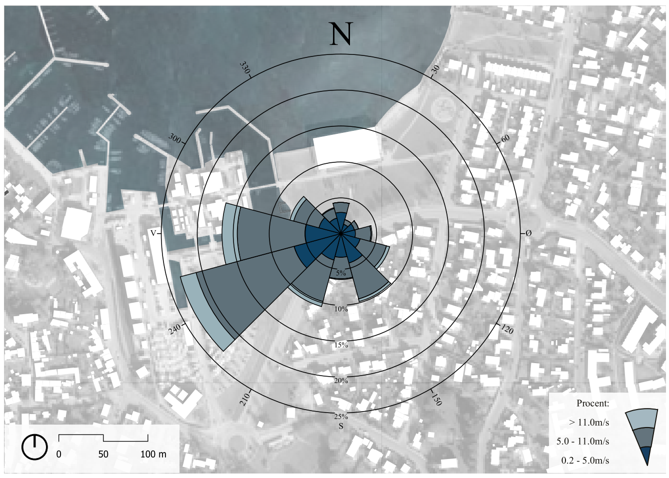
Due to the placement of the museum towards the fjord and the open area towards south, the site is very prone to strong winds. Studying the wind roses created by the Danish Meteorological Institute (Cappelen & Jørgensen, 1999), it is evident that most wind in Roskilde tends to appear towards the West. As the wind direction varies throughout the year it is chosen to focus on the most important seasons. These seasons are further reduced to the most noticeable month containing the strongest wind during the year. It is worth mentioning that the wind roses data has been measured at Roskilde Airport and may cause slight inaccuracies.



Ill. 16, windrose July 1961-90

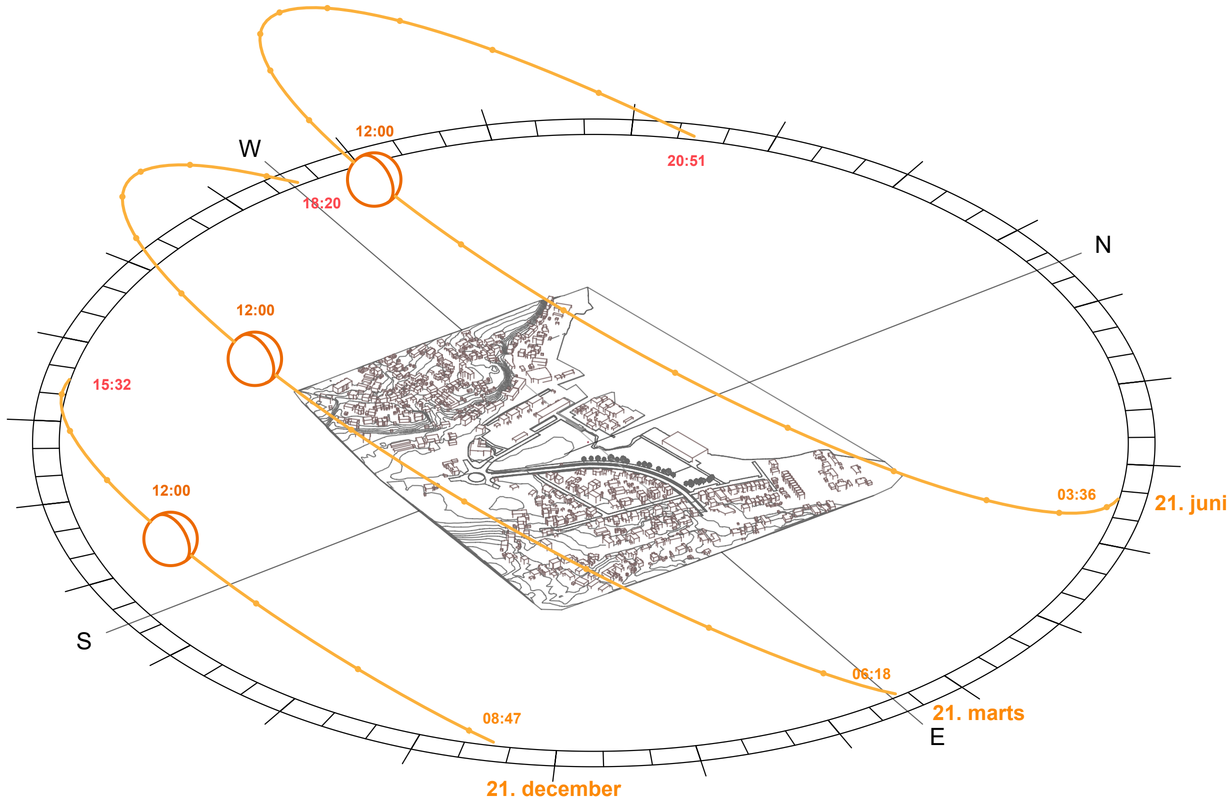
The winter season has the most wind during January. The wind rose shows that a majority appears towards West-Southwest with most of the wind having a speed of 5-11 m/s. This velocity is consistent being the most dominant wind speed. During a site visit it is worth mentioning that the main road curves through the landscape whereas the wind is especially concentrated from this direction causing significant discomfort in the nearest part of the site.

The summer season has its most noticeable month in July which further states that the most dominant direction is towards the West. However, it is also documented to contain a great amount of wind appearing in the East-Southeast direction. The wind rose shows the most frequent velocity appearing toward the West to be 5-11 m/s where the most frequent speed in the East appears to be 0,2-5 m/s.



Ill. 17, windrose January 1961-90

As the site has very little wind protection, it is important to address the potential discomfort when designing the New Viking Ship Museum as the design has to accommodate various outdoor activities throughout the year.



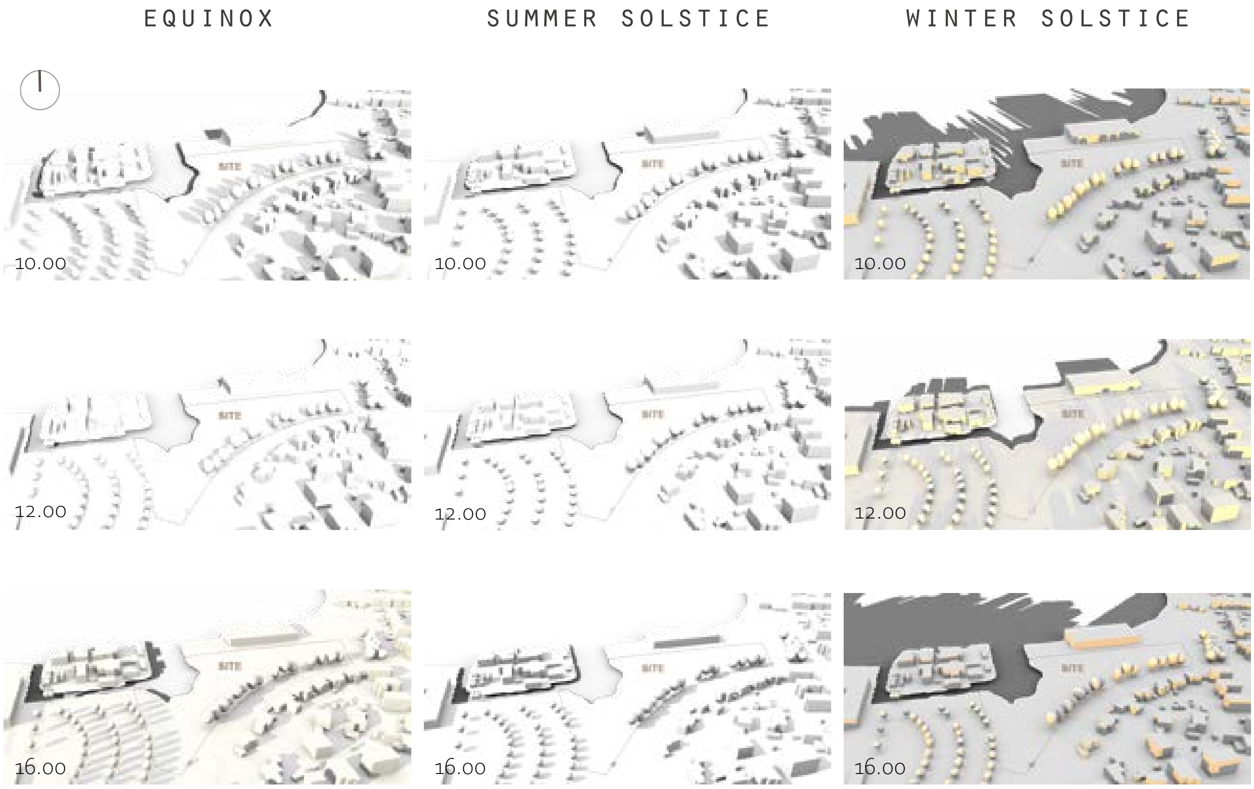
Ill. 18, sun paths

SUN

MICROCLIMATIC ANALYSIS

To obtain comfortable outdoor spaces and optimal building orientation, it is relevant to study the opportunities of placement hereof in terms of sun studies. Natural light and well lit areas will help create an attractive space. As the site is situated in an open area with a low density housing context, their shading impact has been documented in the following study. The study investigates Summer and Winter solstices as well as equinox in certain time points during opening hours of the Viking Ship Museum.

The studies show a main shading influence of the nearby trees as their shadows are impactful in all observed time slots. The winter solstice shows that the topography of the city contributes to a great amount of shading throughout the day with the placement of the context hindering the sunlight. At 12.00 there is a possibility of sunlight on site toward the Southwest due to a break in the row of trees. To create outdoor spaces usable during the winter period this area could be utilized.



Ill. 19, sun analysis on site

In the summer period the amount of shading on site becomes sparse allowing for a great amount of sunlight in general. The angle of the sun makes the context irrelevant due to the open area around the site. Regarding the vision of the museum, the lack of shading creates the demand of utilizing the built environment for outdoor shading ensuring potential overheating of eventual outdoor exhibitions is avoided.

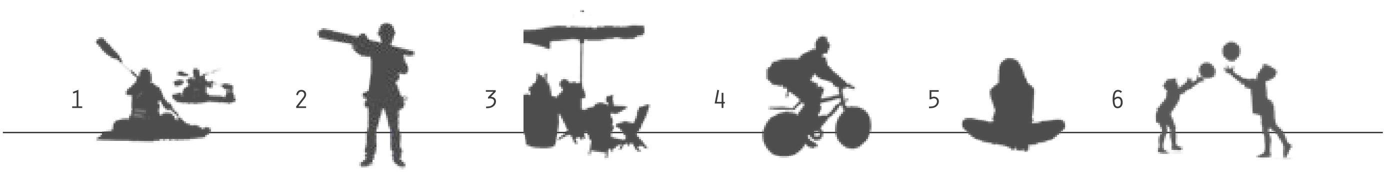
It is noticeable that the Southwest part of the site remains rather devoid of shading making it a focus area for residing throughout the year in terms of sunlight. The trees create natural shading in the southern part of the area making this part of the site ideal for occupancy during warm periods. The northern part of the site remains well-lit throughout the year and contributes to natural light entering the existing museum as well as creating a pleasant path through the museum and the site utilized to connect the museum complex possessing a great quality to preserve.

Ill. 20, accessibility

ACCESSIBILITY & URBAN ACTVITIES

Observing the context it becomes evident how the general movement patterns occur. In general, the heavy traffic appears south of the site, in which the road can be defined as the main traffic contributor near the existing museum. Because of the low density housing, the intensity of heavy traffic is greatly reduced towards South and East allowing for light traffic in terms of pedestrians and cyclists towards the site. The museum area however restricts entry for heavy traffic leading to the harborfront in the West to be a light traffic area. The majority of cyclists and pedestrians use the path south of the museum, becoming a shortcut for light traffic occurrence, as the bridge and water becomes a barrier for vehicles.

These flows allow for a variety of activities to occur around the site. East of the existing museum building, a playground is established allowing children in the vicinity to use the green area whenever they like. Towards the south, the large green area is mainly used by the museum, however the use is limited during winter with the open area appearing abandoned. The museum island allows for various activities most prominently in the form of a café area open all year round. The nearby harbor towards west creates the surroundings for various water-based activities such as kayaking, rowing, sailing, and fishing alongside the museum activities.



Ill. 21, urban activities

Ill. 22, museum functions

MUSEUM ACTIVITIES

The current museum area includes a large part of the harborfront in Roskilde and possesses various activities in correlation to the purpose and theme of the Viking Ship Museum.

The main museum building is located right towards the water and frames the five original viking ship findings among other exhibitions. South of the museum building, the large green area is used during summer for various museum activities and serves as ship storage during winter time.

The island west of the museum building holds various activities that the museum presents as an interactive learning experience with a shipyard along the fjord crafting both replicas of the findings and other variations using their extensive research time accurate ship crafting. The island is connected to the administration building situated at the west also housing a restaurant.

Ill. 23, observation viewpoints

STROLLOLOGICAL OBSERVATIONS

SENSE OF PLACE

A strollology is utilized to look at different views and areas near the site and different angles of approach. The aim of the strollology is to get acquainted with the area and get an understanding of the various atmospheres. Four different routes are selected to understand the surroundings and the impressions when approaching the site.

ROUTE 1 - contrasts
The site of the Museum have the Fjord to the west and green areas to the south-west. The western harbor environment is filled with ships, boats and activities, meanwhile the southern part is calm and open and consists mainly of greenery.

ROUTE 2 - greenery
When approaching the site from the west side, one is met by low-rise and densely built buildings and further down the road, heading to the east part of the site, is where the open green area appears to make the general atmosphere warm and welcoming.

ROUTE 3 - residential buildings
The residential areas on west, east and south are framed by the public roads and paths along with greenery. The many different colors of the surrounding buildings are a part of the atmospheric experience.

ROUTE 4 - traffic & boats
The building is withdrawn from the heavily trafficked roads that contribute unwanted noise, while creating a large open green space, which can be utilized for different purposes; seating, playing or facilitating the ships.

ROUTE 1
CONTRASTS

ROUTE 2
GREENERY

ROUTE 3
RESIDENTIAL BUILDINGS

ROUTE 4
TRAFFIC & BOATS

Ill. 24, observation photographies by Tiba Adnan

MATERIALITY & AESTHETICS

SENSE OF PLACE

The site of the Museum is located around beautiful views towards the Fjord and green areas, as well as Roskilde Cathedral that towers above the tree lines. The areas surrounding the site creates an open and transitional zone between the two atmospheres of the residential area and the harbor environment. The harbor environment is a place filled with ships and boats, activities and historical tales of the viking age.

When passing the Viking Ship Hall, one is met by the concrete facade with a long window tape following the building. The building appears heavy, but also protective, modest and simple, not needing to represent itself in a grand and loud manner. During winter, the atmosphere around the Hall and the surrounding area seems quiet, somewhat closed, low intensity and with space for immersion and experience, whereas in summer, the area has potential to be full of activities and entertainments, providing more life to the area.

A characteristic bridge allows pedestrians to cross the water and enter the Museum Island, through a gateway that frames the passageway and the change in atmosphere. The Museum Island is a main part of the museum experience, where the Boatyard creates a viking atmosphere, and where the wood can be smelled all around. Along the path around the island are different trees and herbs placed, giving a view into materials, growth, and herbs used in the viking age. The buildings are a contrast to the Viking Ship Hall, as they consist of wooden cladding, which provide a better atmospheric experience of a viking settlement, and give the impression of a highly active and playful environment.

OPEN GREEN AREA

BUILDINGS OF THE MUSEUM ISLAND

HARBOR BOUNDARY

A SENSE OF ATMOSHERIC IMPRESSIONS

CHARACTERISTIC BRIDGE

MUSEUM ENTRANCE

Ill. 25, sense of place photographies by Tiba Adnan

03.

THE VIKING SHIP MUSEUM

INTRODUCTION

The Viking Ship Museum is designed by the Danish architect Erik Christian Sørensen and is one of his main works that was protected from 1997, as an example of late modernist architecture, to 2018. The oldest part of the museum; the Viking Ship Hall, opened in 1969 and is built as a large display case that surrounds the five Viking Ships from Skuldelev. These ships are famous worldwide and are of great value as a part of the Danish cultural heritage (vikingeskibsmuseet.dk, 2023A).

The Viking Ship Hall is located towards the Fjord, where a large window area frames the water and the landscapes' horizon, and creates a marvelous background for the five original ships that all seem elegant and slim as they hover above the floor. The architecture is of raw and pure character, making the building modern, rectilinear, but brutal in its appearance, which is a contrast to the ships' elegance and lightness. The building has gained status as a masterpiece in brutalism, and the architecture within the museum has even had such an impact that it can be felt on the Museum Island as well (dac.dk, 2023).

The Museum Island, built in the year 2000, is an open and active environment where reconstructions of the Viking Ships are made, and where experiences are full of sensory expressions and knowledge. This is a place where nature and ship meet in the very same place, where it all took place.

Ill. 26
Photographer: Werner Karrasch
Copyright: Vikingeskibsmuseet i Roskilde

CHALLENGES OF THE MUSEUM

EXISTING MUSEUM CONDITIONS

THE CURRENT STATE

The Viking Ships are currently facing great threats, as the building they are situated in, is no longer capable of protecting the ships against the weather changes, daylight amount and rising water levels. The structural parts of the building cannot withstand the pressure, and despite continuous maintenance, the building's decay has accelerated through the years. The state of the museum became more serious in 2013, when a heavy storm and flood caused severe damage to the building due to the water pressure generated by high tides, storm surge and rising water levels. In 2016, the most exposed structural parts of the building were given an estimated remaining lifespan of 8-10 years, causing the need for a new and durable building to escalate (Vikingeskibsmuseet, 2019A).

THE ELEMENT OF ATTRACTION

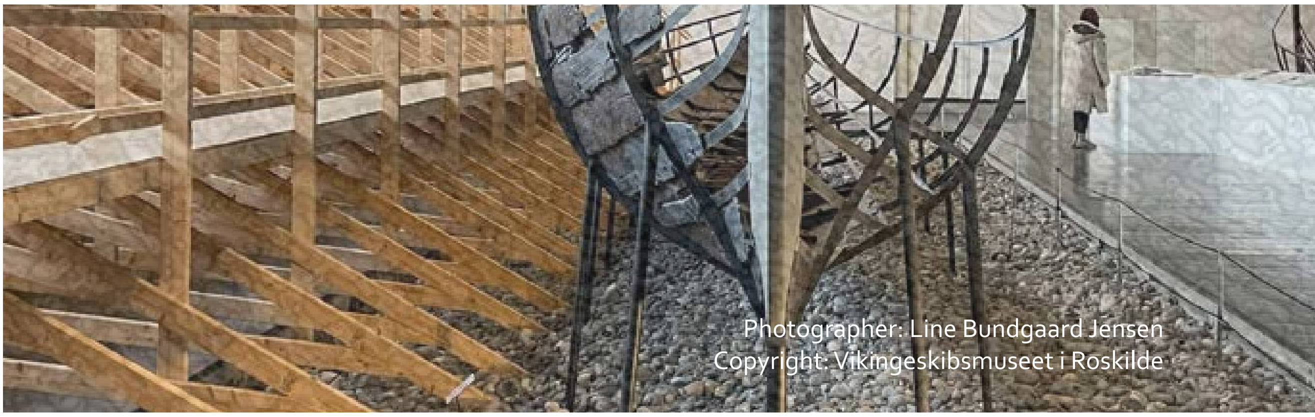
During the summer period, the surrounding environment is filled with activities and energy, where in the winter period, the Viking Ship Hall is the only available element to show and give the visitors the experience of the Museum, which causes a lack of all year round activities that can disseminate the viking age and the stories about the ships. Furthermore, there is a lack of active dissemination of the reconstructed ships during winter, as they are not participating in the full experience of the Museum. The Museum does not have the space to provide a proper dissemination of the original ships and the stories of the vikings either, and must compromise on some of their exhibitions and activities, such as their maritime archaeology research department (appendix 1).

TOWARDS A NEW FUTURE

A new and long-lasting exhibition hall became an opportunity, when the current Hall was delisted in 2018, as a result of the risk of losing the valuable ships. A renovation would not be adequate enough, as the ships would be at continuous risk of rising water levels, indoor climate and frequent renovation work. A permanent solution needs to make sure that the ships can be properly preserved regarding indoor environmental qualities and withstand the unpredictable weather developments (Vikingeskibsmuseet, 2019A).

A new building would further be able to improve the accessibility and make the building more active and welcoming for all visitors, as well as including and actively engaging these in experiencing the stories of the ships and the viking era.

FLOODPROOFING



DISSEMINATION

EROSION

RISING WATER

Ill. 27, challenges of the current museum, by Tiba Adnan

THE EXHIBITIONS

EXISTING MUSEUM CONDITIONS

The exhibitions at the museum are modern historical narratives about the Vikings and their ships, where the exhibitions are displayed through traditional museum communication in text and images combined with lights, sound, digital installations, activities, and artistic expressions to make the maritime history vivid, for both adults and young ones (vikingeskibsmuseet.dk, 2023B).

THE FIVE VIKING SHIPS

The five original viking ships were used, in the late viking age, as a defense system of barriers in Roskilde Fjord, to make it possible to control the sea routes. The ships were filled with stones and lowered into the water, where they a thousand years later were excavated. The exhibition of the Viking Ships provides a unique perspective on the Viking Age maritime culture of shipbuilding, seamanship, trade, defense and warfare as well as the possibilities of traveling far and wide to explore new horizons.

THE FIVE RECONSTRUCTIONS

Since the excavation of the five Viking Ships, all five ships have been reconstructed in order to provide a view into how the ships looked a thousand years ago. Each ship tells a story about the viking age - the shape tells about the function of it, the wooden fibre structure tells about the construction and use of tools. These reconstructions are, during summer season, located in the Museum harbor alongside the traditional wooden boats, which along with the harbor environment creates a bridge between history and traditions.

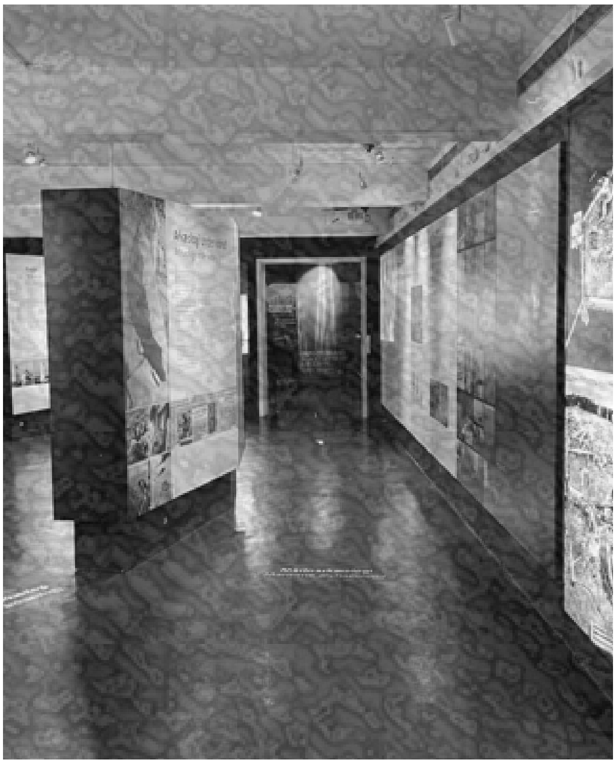
CLIMB ABOARD

The exhibition Climb Aboard is a tale of the Viking's journey across the open sea. The walls in the exhibitions become vivid with a cinematic projection in the distance, where lights and recordings of sounds are used as a tool to create the proper setting and atmosphere. One of the walls is filled with a curated collection of objects, printed quotes, images and illustrations that reports of the objects and the life on board the ships (vikingeskibsmuseet.dk, 2023C).

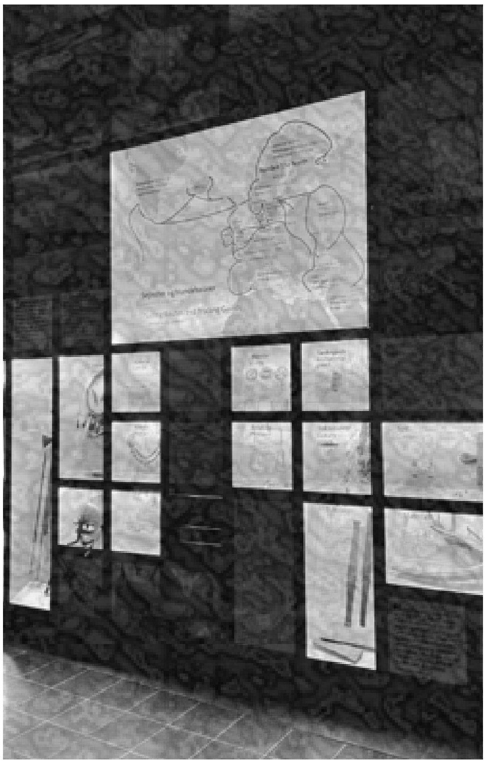
SPECIAL EXHIBITION

'In the Wake of the Vikings' is the tale of how the discovery of the five Viking Ships has had remarkable importance in maritime archaeology in Denmark, and how this has been a part in shaping the Viking Ship Museum and enhanced archeological experiments in reconstructions and sailing. The five ships contributed with new knowledge of the North's maritime culture, and explored a new world; the viking age (vikingeskibsmuseet.dk, 2023B).

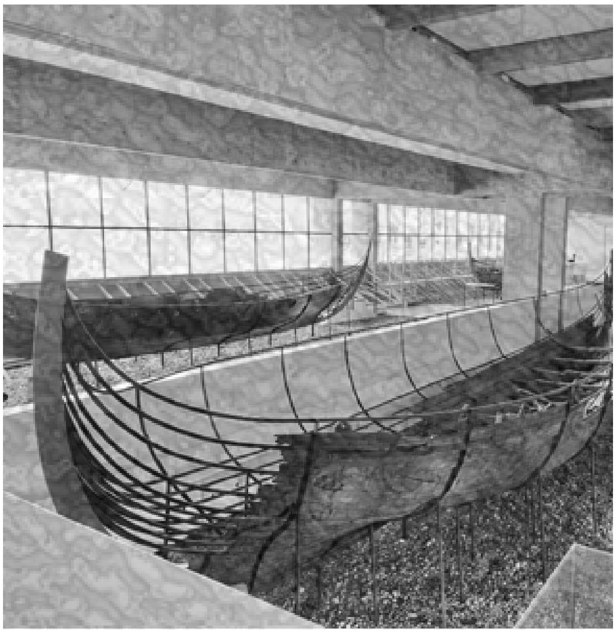
SPECIAL EXHIBITION



CLIMB ABOARD



THE FIVE VIKING SHIPS



THE VIKING SHIP MUSEUM

SPECIAL EXHIBITION

Photographer: Line Bundgaard Jensen
Copyright: Vikingeskibsmuseet i Roskilde

CLIMB ABOARD

Ill. 28, exhibitions at the viking ship museum in Roskilde

PRESENTING LARGE ARTIFACTS

EXISTING MUSEUM CONDITIONS

Displaying large objects in a museum can be a challenge. Over the years, museums have used different approaches such as using outdoor spaces, creating special doors or even built a museum around larger artifacts. Some artifacts require special care and accommodations in order for them to be kept available for interpretation and visitor enjoyment (Mall History, n.d.).

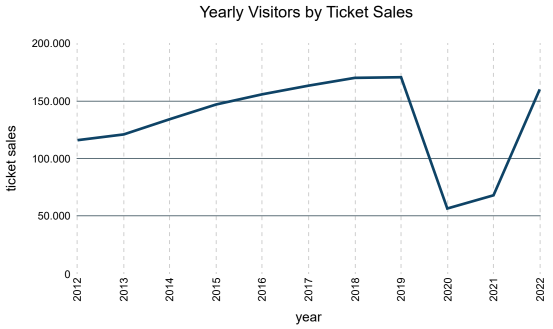
The architectural quality can be utilized for different approaches within a museum, to create a controlled and fulfilled atmosphere, a specific setting or the proper way to disseminate an object. A museum with aircrafts and space vehicles could be designed with large windows to create a visual effect that brings the sky to flight-themed exhibitions, as is the case with the Smithsonian National Air and Space Museum. A museum showcasing ships, in a historical manner or not, could utilize water in a way to provoke the natural setting of the ships, as is the case in The Viking Ship Museum in Roskilde, where the fjord is used as an atmospheric element.

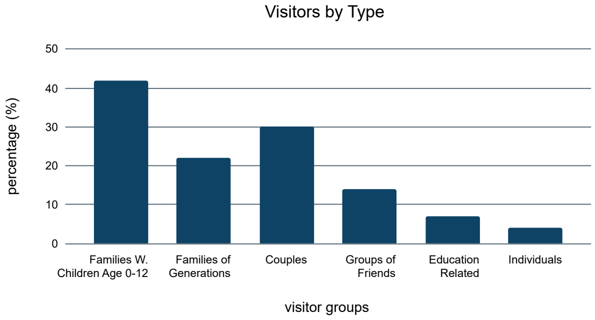
The Viking Ship Museum in Roskilde was built around the artifacts, as one large display case, with the ships elevated from the ground and with the fjord as background. In this way, the water is being used as the experiencing element that provokes the natural setting of the ships, and thereby creating a stronger quality for the presentation of the artifacts.

Ill. 29
Photographer: Werner Karrasch
Copyright: Vikingeskibsmuseet i Roskilde

THE VISITORS

EXISTING MUSEUM CONDITIONS





Ill. 30, visitor graphs

During the past 10 years it is clear that the Viking Ship Museum has experienced a development of the number of visitors. The yearly number of visitors can be seen to have a steady rise reaching a highpoint of 170.547 in 2019 (Damgård-Sørensen & Weichel, 2019). The number decreased dramatically in 2020 due to COVID-19 restrictions and shutdown of the museum with a small improvement the following year. By 2022 because of removed travel restrictions, the museum experienced a boom of visitors (Johansen, 2023).

The museum attracts a vast amount of different visitors which is documented by national user surveys. An in depth survey conducted by Rambøll depicts the visitors by type showcasing a majority of families, particularly with children, visiting the museum. Interestingly, the second most dominant visitor type tends to be couples. Other visitors consist of groups of friends or individuals, however these types do not constitute the visiting majority. (Rambøll, 2017)

Additionally, the visitors by educational purposes provide little visitation activity in the museum area of 7 % of the total number of visitors (Danmarks Statistik, 2019). The survey allowed for multiple answers to be selected and was conducted in 2017 which may cause a small inaccuracy in actual numbers, however it gives a representable distribution of the museum visitors.

The museum possesses a broad appeal to certain visitor types by their interactive museum experience. This supports the large percentage of families with children as the museum island offers on-hands activities experiencing the tales that the museum conveys differently. Their ship-building workshops and the opportunity of sailing in their on-site constructed viking ships replicas communicates an alternative museum experience to appeal to children and people with such interest in different ways than a typical museum exhibition experience. These activities are proven to be popular as the number of visitors peaks during the summer period where it is possible to carry out these events.

During wintertime, the visiting amount of people substantially decreased (appendix 1). During an on-site visit, the Viking Ship Hall seemed almost quiet while the museum island had an impression of being almost abandoned. The surrounding areas of the museum seemed rather deserted, indicating no available activities of visitor engagement taking place.

SAFEGUARDING THE VIKING SHIPS

A new dissemination hall preserving the findings in optimal climate conditions

FINDINGS HISTORY

Communicating the story of the five viking ships; from usage to cultural heritage

NEW DISSEMINATION SPACES

New spaces for exhibitions and teaching activities supporting the maritime roots of the museum

THREE PRIMARY NARRATIVES

The international history of the vikings and their influence, presented with a maritime starting point

The evolution of the ship using the collection of the museum; from early boat findings to highly developed viking ships and beyond

Museum history on underwater investigations; discoveries emerging as new sources for history

UNIQUE MUSEUM PROFILE

Utilizing the existing active environment for engaging education and dissemination

GATEWAY

Act as the starting point to the new national park "Skjoldungernes Land"

PRESENTING HISTORY IN A MODERN SETTING

Create a pleasant place providing optimal spaces to learn, relax, and experience viking history through a contemporary museum design

NO VIKING SHIPS, NO VIKING AGE

Illustrate the connection between ships and seafaring and the establishment of the northern kingdoms and the following development

LOCAL AWARENESS

Must contribute to a vibrant harbor

Existing 'water users' and their activities must be retained

Residents and visitors must continue having access to the fjord and the water

Connect the fjord and town and strengthen the relation between harbor and town

ALL YEAR RELEVANCE

Making engaging experiences throughout the year

Be able to exhibit or storage replicas during winter period

RETAINING QUALITIES

Excellent staging of the ships

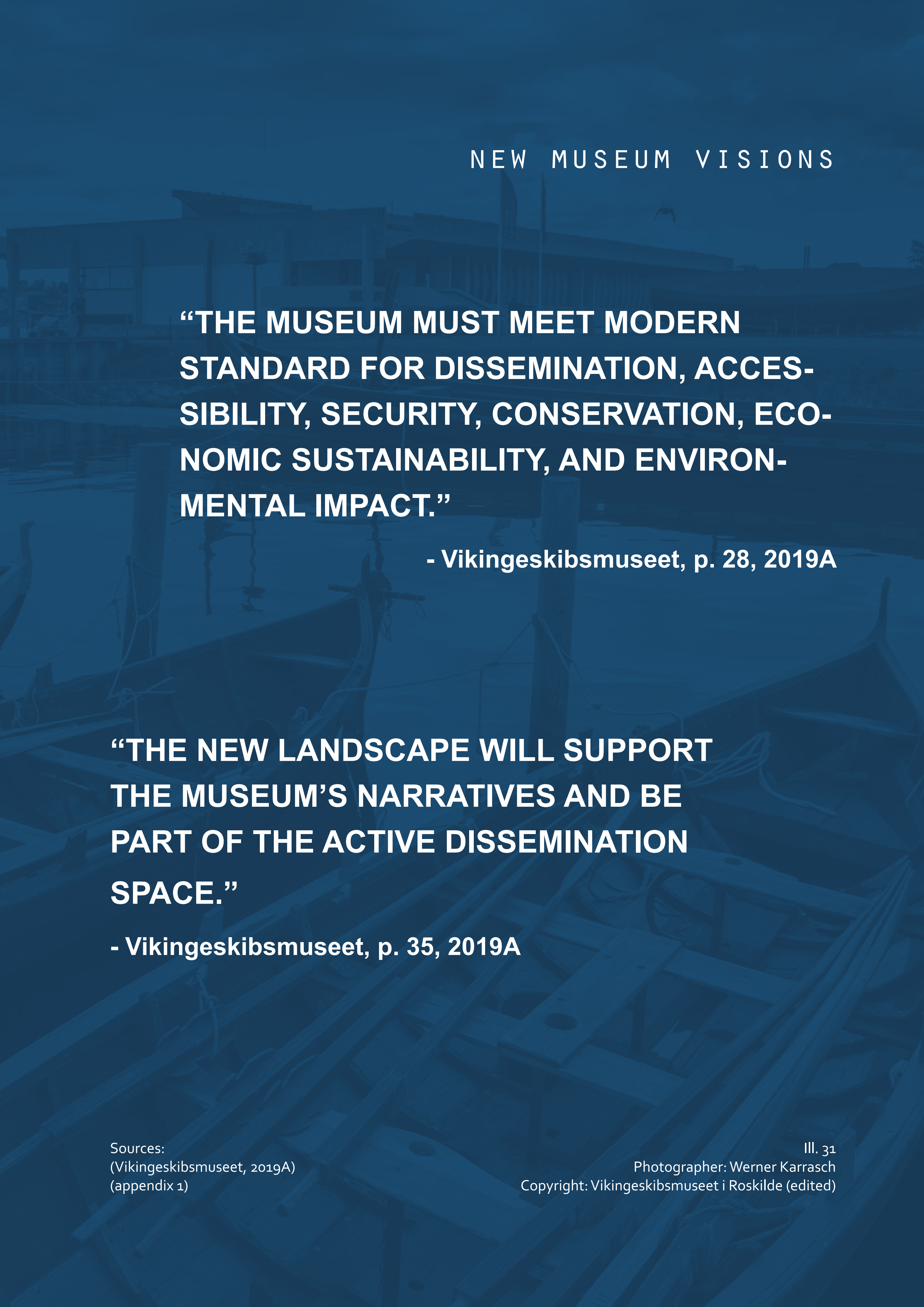
Feeling of life and the proximity to history

Emphasis on lines and shape presenting the ship in minimalist spaces

Honest architecture

ARRIVAL

Create one clear entry point for the museum area



"THE MUSEUM MUST MEET MODERN STANDARD FOR DISSEMINATION, ACCESSIBILITY, SECURITY, CONSERVATION, ECONOMIC SUSTAINABILITY, AND ENVIRONMENTAL IMPACT."

- Vikingeskibsmuseet, p. 28, 2019A

"THE NEW LANDSCAPE WILL SUPPORT THE MUSEUM'S NARRATIVES AND BE PART OF THE ACTIVE DISSEMINATION SPACE."

- Vikingeskibsmuseet, p. 35, 2019A

Sources:
(Vikingeskibsmuseet, 2019A)
(appendix 1)

Ill. 31
Photographer: Werner Karrasch

PRESERVATIONS OF THE SHIPS

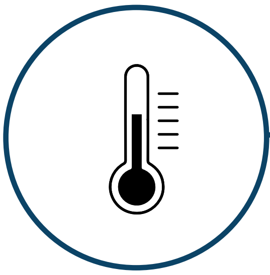
NEW MUSEUM CONDITIONS

The Viking Ships are an important part of the Danish cultural heritage and are of irreplaceable value. The Ships are currently threatened by elevated water levels, radiation, and the indoor climate, and must be transferred to a new building where thermal sensitivity is of high importance. The thermal sensitivity is defined by the amount of humidity, temperature, light, and radiation an object can endure before decomposing (Museernes Arbejdsopgaver, 2021A).

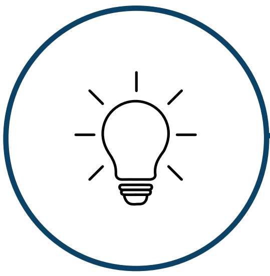
Most museum objects will be properly preserved at an indoor climate of 40-60% relative humidity and a temperature between 16-25 degrees, but for some exhibitions, more narrow restrictions are needed (Museernes Arbejdsopgaver, 2021B). In exhibitions with archaeological objects, originating from particularly salty locations, such as maritime archaeological objects, will require a high level of stability in its climate with a low relative humidity.

Exhibitions without any control of the climate and with fluctuations in the humidity will result in renewed salt migrations and peeling of the surfaces of the objects (Museernes Arbejdsopgaver, 2021A).

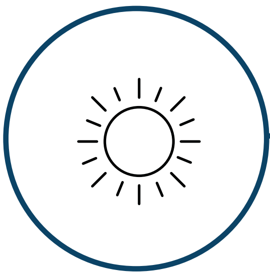
The relative humidity is important in relation to preserving the objects, and often relates to organic materials' dimensional stability, corrosion of metals, and the risk of mold and pests.



The temperature is important in relation to the chemical decomposition, where a low temperature can be crucial for a slow decomposition of many organic materials, while others will be damaged due to sensitivity regarding low temperatures.



The light is important in relation to visible changes in the objects, where the amount of light is defined by a maximum value an object can endure, before getting visibly damaged. For most inorganic materials, there is no defined upper limit due to conservation considerations, but due to the adaptation of the eye.



The radiation is important in relation to sensitivity towards the sunlight, which is preferred to be avoided completely. However, an acceptable upper limit is in general 75 uW/lumen, but due to modern light sources filtering most of the UV-rays, the value is typically between 0-18 uW/lumen.

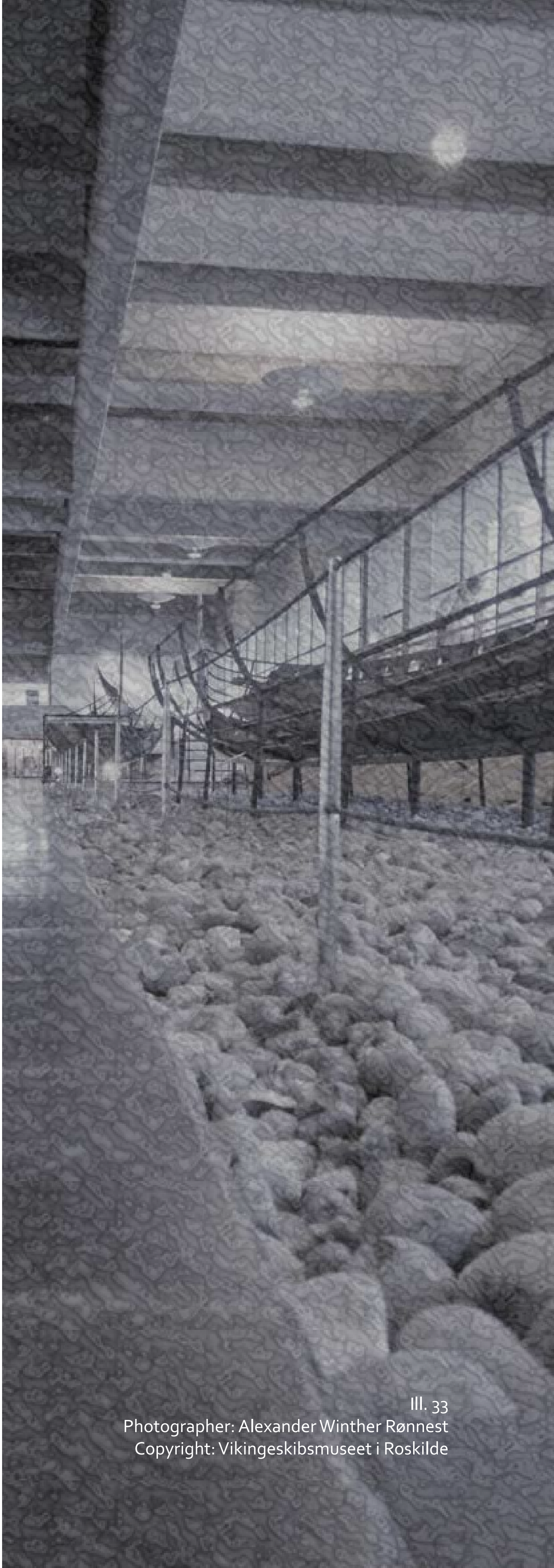
Ill. 32, thermal comfort factors

The Viking Ship Museum is part of the more narrow category as the valuable ships are maritime excavations, which means the indoor climate of the exhibitions must be controllable and adjustable within the narrow boundaries of temperature, humidity, air quality, sunlight and radiation, which applies in both the room of the ships, but also the nearby transition zones. Only moderate fluctuations are allowed in the climate, as larger and more frequent fluctuations over time, can cause damage to the ships and accelerate the decomposition (appendix 1).

The ships are very fragile in their surface and in their structure, making it necessary that the ships are not exposed to dust particles that will require risky cleaning activities, which means that ventilation principles and zoning must participate in avoiding dust and sediments attaching to the surfaces of the ships. Furthermore, an effective zoning also contributes to avoiding influence from the ships' surrounding zones regarding temperature and humidity.

The nearby zones of the ships must keep a humidity at 45-55% with fluctuations at a maximum of +/- 5% over 24 hours, and must keep a temperature at 18-23 degrees, where every other zone has no specific requirements for humidity, and the temperature will remain on a comfort level at 20-26 degrees.

Another important consideration is the sunlight and radiation, as it is harmful for the ships and must be avoided if possible. This means that precautions to sunlight entering the building must be considered, as well as sun protection and blackouts must be incorporated to control the amount of daylight and secure the indoor climate. The radiation must be as close to 0 ug/lumen as possible and the lighting must not exceed the maximum of 1500 luxhours within 24 hours.

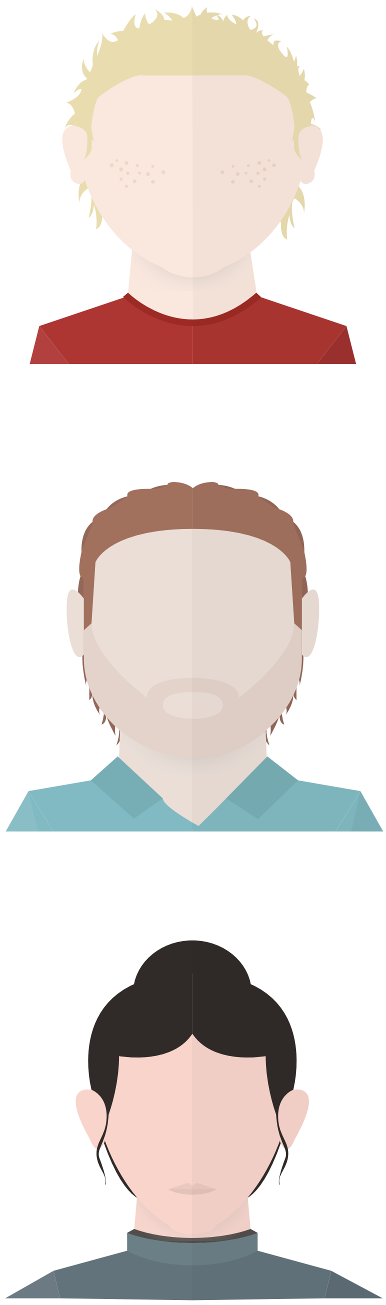


Ill. 33
Photographer: Alexander Winther Rønnest

THE VISITING PERSONAS

NEW MUSEUM CONDITIONS

As a basis for the development of the competition, the Viking Ship Museum had arranged an information meeting to the community making it possible for the neighborhood and other interested parties to voice their ideas and visions for the New Viking Ship Museum (Vikingeskibsmuseet, 2019B). These statements have been assessed and compiled into this project, creating the following three personas.



Ill. 34, personas

THE ACTIVE AND EXPLORING CHILD

When asking Thomas, one of the main ideas mentioned was to create a larger museum to make space for more activities as these were the most interesting parts of visiting The Viking Ship Museum. He would like to have a larger space to play around as a true viking and see the actual sailing ships in the harbor up close with all their attributions because they are just placed outside covered in wintertime.

THE CHILD- AND EXPERIENCE ORIENTED ADULT

Rasmus is very much focused on an experiential development of the museum. He imagines the new museum buildings being inspired by the building principles and environments of the viking age with a walkable roof and a café looking out at the fjord. The accessibility for handicapped people in the harbor area should be improved as well, also allowing wheelchair users to experience the exhibitions.
He also thinks it would be beneficial for the museum to include more general tales of the vikings including sagas as well as exhibiting lives and travels of the vikings. Devoting a larger area for flexible exhibitions will ensure a greater variation in the content making the museum more revisitable. In addition, he suggests implementing more winter activities about the vikings to maintain the vivid atmosphere of the museum all year.

MARITIME AND BOAT INTERESTED ADULT

Vicky is enthusiastic about the maritime part of the museum. Her ultimate opinion is for the museum to give back the view of the fjord to the people of Roskilde either directly or through transparency and natural lighting, emphasizing on the view both inside and outside of the museum. She thinks the main focus of the museum has been lost and the exhibitions should be focused on sailing and the marine archaeology that the museum conducts. Additionally it would be interesting to include a narration of the materials used, and still being used, in the construction of the viking ships and the replicas as the construction part itself can be experienced.

"The combination of the view, the access to the water, and the free entry are qualities that give great value to the area. It is one of the few places where the fjord is visible passing by in traffic"

"The museum is an area that frames the meeting of nature and man"

"Carry on the atmosphere at the museum and the surroundings just like the atmosphere on the museum island and the shipyard maintaining the active and vivid museum, while also creating a calm and immersive quality."

Ill. 35
Photographer: Line Bundgaard Jensen

04. THEMES

Ill. 36
Photographer: Werner Karrasch

VIKING ARCHITECTURE

Vikings are famous for their viking ships which serves as the heart of the museum's exhibition. However impressive engineering and design as they may be, these vessels were not the only structural phenomena during this era. Taking a look at their housing one will find interesting and impressive principles utilized in their architecture.

Their housing is developed by a simple principle of a longhouse deriving from techniques of earlier house designs developed by farmers around 3.900 B.C. housing both man and farm animals in each end of the house with a central fireplace making use of the enclosed space to obtain a heated space for occupation. While the Viking Age longhouses in principle possess the same purpose, a clear development of the architecture obtained larger housing allowing for a more convenient interior design. (Lauring, 2022). However, several archaeological findings show evidence of different ways of constructions with certain similarities.

FRAME STRUCTURE PRINCIPLES

Several halls have been documented as having curved exterior walls with two rows of interior columns and oblique columns along the exterior walls supporting the roof. The interior columns allowed for clear division of the building resembling a kind of modular system by their repetitive distances. These columns were connected with beams to each other and the outer wall columns creating a frame structure accompanied by oblique columns because of their instability. (Schmidt, 1999)

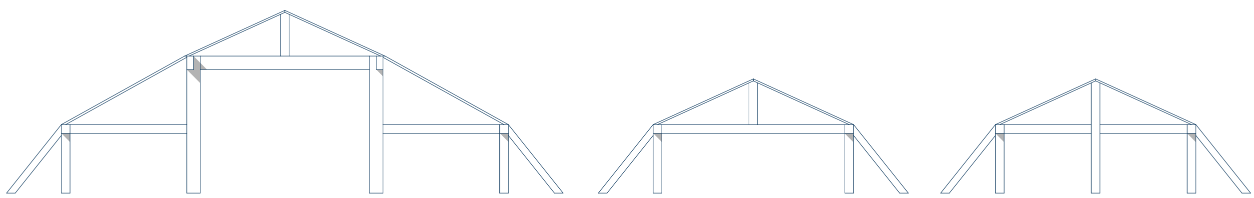
The shape of the building creates a ship-shaped roof as the ridge curves down towards the gables, though later on in the iron age the hipped ends were replaced with vertical gables. As the main material used was wood and various elements being dug directly into the ground, it has resulted in all original houses of the time being gone with only archaeological pieces preserved to give insight to their constructive abilities by the placements of the columns (Schmidt, 1999) (Lauring, 2022).

In other parts of Denmark and notably in smaller houses, the interior columns were either omitted or the amount was greatly reduced hidden in interior walls. In some cases, the ridge of the roof was carried by smaller columns placed upon the cross beams, although their structural success also created the need for external wall support. (Schmidt, 1999)

ARCHITECTURAL FINISHES

The wall structures likewise varied possibly in a single longhouse alone. The findings show that the builders used wood in various ways to create the basic structure of the walls. All methods included clinching the wall with clay and turf keeping it waterproof. One method consists of using posts in which split oak timber is braided around the house using the structural posts in the exterior walls as well, creating an even finish when clinched.

Another method consists of using vertical wooden timber planks. These planks were put together fastened either directly into the ground keeping them upwards or in a tongue and groove-like system in a ground-placed beam. In some cases this system is also used to join the planks upwards. As the braided wall is secured by clinching it is assumed that this type of wall had similar treatment.



Ill. 37, frame structure principles

A third method consists of horizontally placed wooden planks, or bole building, stacking the planks to close the wall. Clinching this wall type varies being on either side. The findings show that the latter two mentioned wall methods were used to construct the inner walls as well. Additionally, the wood most commonly found has been oak serving as both load-bearing structures and several elements in the wall structures. (Schmidt, 1999)

As for roofing the longhouses, there has been evidence of the builders using wood shavings creating a shingle roof consisting of similar treesorts. The individual shingle had rather large dimensions with one shingle used for a great hall spanning approximately 56 x 27 cm.

Different formings have been documented varying from triangular, rounded, rectangular and such. To give the interior a more clean look, the builders constructed a wooden plank roofing placed underneath the shingle roofing strengthening the roof construction itself. Other sites suggest the use of thatched roofs on smaller houses as well as using turf as roofing material, though with precautions of its accuracy. (Schmidt, 1999)

THE CIRCUMSCRIBED SHIP

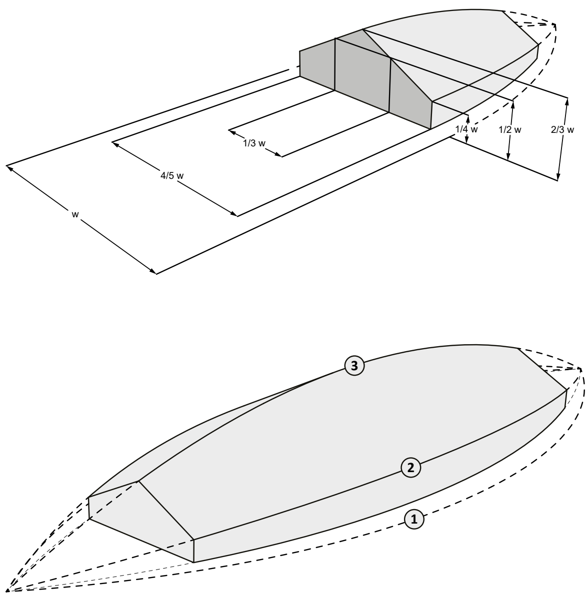
The characteristic form of the design of the longhouses relates to the use of circular arcs, a geometric theory called "the circumscribed ship" by Bente Draiby. This theory presents a parametric design principle with circular arcs all relating to the initial width of the longhouse determining the measurements of the building three dimensionally and the ideal house form using three circular arcs. These arcs define in plan 1) the foot of the exterior oblique columns, 2) the bottom of the roof and top of wall, and 3) the roof ridge.

As the ship builders in the Viking Age shaped their ships during the building process only using a few simple calculations, it is assumed that building a house would have followed the same principle. The theory suggests that by using the initial width of the longhouse all other measures can be determined by fractions of this.

The width of the house "w" determines the length of the house and can be described, through archaeological discoveries, with the proportion "4w". Similarly every other measure can be defined with the height of the wall being "1/4w", the height of the roof-carrying columns being "1/2w", and the full height of the house being "2/3w". In plan the distance between the two long walls will be "4/5w" while the distance between each pair of roof-carrying columns are "1/3w".

These definitions make it easy to define any other dimension both vertically and horizontally as fractions of "w" regardless of where one stands in the length axis of the house. (Kristiansen, n.d.)

The principles used to construct the longhouses defined the architecture throughout the Viking Age and has become synonymous with the era. Understanding the structure and design for this era provides a picture of their constructional abilities and their way of making each building unique. Such principles and approaches will be used as an inspiration and considered throughout the design process.



Ill. 38, the circumscribed ship

ATMOSPHERE

Atmosphere can be defined as, on one hand, the physical perspectives that reflect the atmosphere of a place; on the other hand, as the character or aura which surrounds and defines a place. Aura is defined by Böhme while physical approach is defined by Peter Zumthor where in his 2003 lecture on "Atmospheres" he describes it as a timeless culmination of visual qualities embedded in a design (Zumthor, 2006).

ATMOSPHERE AS AN EXPERIENCE

In his book, The Aesthetics of Atmospheres, Gernot Böhme theory underlines that the word " atmosphere " has been developed through history and can be determined by many parameters (Böhme, 2017).

Looking back at history the extraordinary advantage of an aesthetics of atmospheres is that it relies on a broad repository of everyday experiences such as "bright" valley, of an "oppressive atmosphere" or even what's called the "tense atmosphere" of a meeting etc. These everyday based experiences and ways of speaking had later made the term atmosphere develop into a scientific concept. It's understood as something in between subject and object:

"Subject and Object can be defined as more or less objective sentiments indeterminately projected into the environment. [...] they have to be defined as subjective insofar as they are predicated on a subject experiencing them. Yet it is precisely in this intermediacy that its great value lies, for through it is united what traditionally has been separate: as an aesthetics of production on the one hand and an aesthetics of reception on the other." - Böhme, 2017, p. 168

In other words what he means is that atmospheres can be created and there are elaborate arts that deal specifically with this creation. These arts revolve around the deployment of eminently material, technical devices and considered to be generators of different atmospheres. On the other hand, atmospheres are experienced in a state of affective

Ill. 39
Photographer: Tiba Adnan
Copyright: Vikingeskibsmuseet i Roskilde

resonance and therefore we have to be physically appearing in a space, in order to perceive them in our particular frame of mind. So atmospheres are experienced with regard to what creates them: objects, their features, arrangements, light, sound, etc. (Böhme, 2017).

ARCHITECTURAL ATMOSPHERE

The other aspect of the atmosphere is based on Zumthor theory determining that all individuals are unique, sentient beings. The body is considered to be consisting of sensory receptors which enables the human being to experience the built environment through the whole spectrum of senses and this is according to Swiss architect Peter Zumthor, is what atmosphere is all about centered around:

"Quality architecture to me is when a building manages to move me. What on earth is it that moves me? How can I get it into my own work? [...] One word for it is atmosphere." - Zumthor, 2006, p. 11

Peter Zumthor also describes architectural atmosphere as an intensity of feeling or mood invoked by the physical / architectural characteristics of a space, which is based on his own career-long pursuit of creating "moving" atmospheres with his architecture. He believes that the atmosphere of a place is a culmination of its "noises, colors, material presences, textures" and most of all, its form. These design qualities can imply temperature, create tension between inside and outside, intimacy or even movement.

This approach focuses on the fact that the perceived atmosphere of a place is deeply connected to the time-specific context (its place in history) of the experience itself, not to mention the state or mood of the visitors themselves. This could be related to historical events, popular culture, and physical surroundings. Atmosphere is a "continuous propagation" of time, space and user.

This approach to atmosphere reflects the ideology of critical regionalism from the 1980's and encourages it to endeavor to create contextual and stimulating architecture, prioritizing in that way the phenomenological experience.

LIGHT

Light is an abstract natural phenomenon which can be controlled and made tangible by man. It serves as the intermediary between form and space in its interaction with architecture, as its ever changing pattern affects the experience of the built environment (Böhme, 2017).

The first effect of light is what is called qua brightness is that it opens up a space. In a sense, that space feels like it is created by light. This kind of space, regarding Böhme, is a space where that light creates the distances, extent, and remoteness. In other words it's a clear space combined with a typical transformation between darkness and lightness where the space around us allows room for free movement. In addition to clear space, there are other phenomena of light – light space, and lights in space - where both of them focus on experiencing the open space but are not as determined for distances as the clear space.

In that sense the lights in space are not perceived as a source of light, but instead they supply the clearest proof that you can see light.

Light spaces on the hand are often seen in museums, where a space created by light virtually from outside, more or less as an object. He refers to it in one example, Museum of Modern Art in Frankfurt where a picture is floating on the wall made of even, colored light and when looking closer the room opens in the wall into a hazily illuminated exterior, of indeterminate depth.

Experiencing the light in that way makes one feel like a space has a dreamlike quality. This phenomenon, which is demonstrated by art in pure form, could play a part in other light experiences in impure form, i.e. mixed and with other phenomena superimposed on it.

MATERIAL RESEARCH

LIFE CYCLE ASSESSMENT

In order to create a variation in atmospheres, different materials impact on the environment have been investigated. This is made by utilizing the Life Cycle Assessment (LCA), where the focus will be on both the atmosphere different materials create, but also the global warming potential (GWP).

The following tables show the GWP for different materials and construction parts, which will be used for the new museum. Most of the shown data is generic data from the Koten plug-in in Revit and the rest from Ubakus (Ubakus.de, n.d.). These analyses, along with the acoustical analysis, will act as the foundation for the choice of the Museum's final materials. The tables are considered to be a reference when making decisions while designing different atmospheres, structural elements and facades, which will ensure that the LCA is integrated into the design already from the very beginning of the design process.

The chosen materials will be further visualized, acoustically and structurally calculated and adjusted to achieve the desired atmospheres and expressions.

TERRAIN

MATERIAL	CONRETE	WOOD
GWP (KG CO_2 EQ./M^2/YEAR)	1,29	-1,525
ATMOSPHERE	out of sight	out of sight
ADDITIONAL NOTES	require little maintenance compared to wood	can be utilized for light construction

FLOOR

MATERIAL	CONCRETE	CLT	WOOD	LINOLEUM
GWP (KG CO_2 EQ./M^2/YEAR)	1,29	0,16	-1,525	0,2185
ATMOSPHERE	neutral color	homey feeling	board gaps can help acoustics	neutral color
ADDITIONAL NOTES	heavy construction	medium construction	light construction	can enhance collections

WINDOWS

MATERIAL	WOOD 2-LAYER GLASS	WOOD/ALM. 3-LAYER GLASS
GWP (KG CO_2 EQ./M^2/YEAR)	1,69	3,25
ATMOSPHERE	warm	better U-value
ADDITIONAL NOTES	wood framing provide better buffer against outdoor noise	less maintenance and lighter than wood

EXTERIOR WALL CLADDING

MATERIAL	UNTREATED WOOD	THERMOWOOD
GWP (KG CO_2 EQ./M^2/YEAR)	-1,525	0,762
ATMOSPHERE	turns into a light grey color over time	becomes slightly darker over time
ADDITIONAL NOTES	very low GWP	resistant to fungus and matches the facades of the museum island

WALL CONSTRUCTIONS

MATERIAL	CLT - 300 MM INSULATION	STEEL - 300 MM INSULATION
GWP (KG CO_2 EQ./M^2/YEAR)	1,02	1,78
ATMOSPHERE	can be utilized for the overall structural system in the museum	can be utilized for the Viking Ship Hall load-bearing columns
ADDITIONAL NOTES	wood fibre insulation provides climate protection	steel columns are eye-catching

INTERIOR WALL CLADDING

MATERIAL	LAMELLA	GYPSUM	CONCRETE	PLYWOOD
GWP (KG CO_2 EQ./M^2/YEAR)		0,2445	1,29	-0,075
ATMOSPHERE	warmth, texture and depth	enhance the museums' collections	enhance the museums' collections	homey feeling, smooth texture
ADDITIONAL NOTES	improve acoustical experience	can be used in additional exhibitions	can be used in additional exhibitions	can be treated to withstand moisture

ROOF

MATERIAL	ASPHALT	WOOD	SLATE	GREEN ROOF
GWP (KG CO_2 EQ./M^2/YEAR)	0,62	-1,238	0,5442	-2,6
ATMOSPHERE	suits dark facades	stylish appearance	suits dark facades	can moderate the heat island effect
ADDITIONAL NOTES	resistant to ext-reme tempera-tures and fire	will enhance solar panels	heavy and af-fects the load-bearing system	not suitable for PV panels

05. SUMMARY

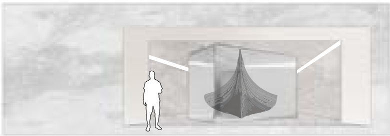
Ill. 40
Photographer: Tiba Adnan

ROOM PROGRAM

Function	Area (m^2)	Amount	Total area (m^2)	Properties
Lobby			**541**	
Foyer + reception	126	1	126	Open area, welcoming feeling - Buying tickets, information about the museum; activity calender, tour guides etc.
Break room	88	1	88	Possibilities for seating, relaxing and eating
Museum shop	140	1	140	Connected to the foyer to make the visitors naturally pass by
Kiosk	15	1	15	Possibilities for buying smaller beverages
Workshop area	148	1	148	Working with archaeological finds or other hands-on tasks
Wardrobe	24	1	24	Connected to the foyer for easy access for the visitors, containing lockers and space for outerwear and bags
Exhibition areas			**3301**	
The Five Original Viking Ships	2061	1	2061	Humidity at 45-55%, temperature at 18-23 degrees, radiation as close to 0 ug/lumen as possible, lighting must not exceed the maximum of 1500 luxhours within 24 hours
History of Findings	130	1	130	1:20 scale of the excavation site - (room shaped as this), display cases, posters etc.
Climb Aboard	213	1	213	Dark room with lights, sounds and video projection to fill the room with atmospheric and sensory experiences - interactive life-size ships to explore
Ship Evolution	340	1	340	Posters, two storey room with views to a few of the reconstructed ships via plateau
Viking History	227	1	227	Posters, artifcacts, interactive with small "workshops", village style
Archaeological	170	1	170	Display cases, posters, underwater feeling
Video Media	60	1	60	Dark room, video projector, seating places
Transitional Space	100	1	100	Possibilities of taking a rest

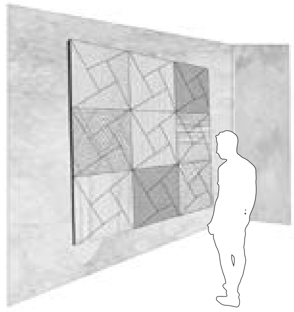
Function	Area (m²)	Amount	Total area (m²)	Properties
Archaeological department			**215**	
Permanent office space	37	1	37	4 permanent office spaces, 2 in each office, requires dayligth, flexible space
Flexible office space	25	1	25	4 flexible office spaces for maritime archaeologists and visiting researchers, requires daylight, flexible space
Visible workspace	61	1	61	Area for working with findings, needs space for a water tank for archaeological wood
Private workspace	32	1	32	Area for working with findings, needs space for a water tank for archaeological wood
Drawings office	35	1	35	Area for working with ships drawings, plotter, etc.
Break room	19	1	19	Dining area with a kitchenette, wants daylight
Toilets	3	2	6	
Services			**518**	
Restrooms (5 toilets)	20	2	40	
H. restroom	9	1	9	
Technical room	42	1	42	Two technical rooms to handle different zones
Technical room - basement	70	1	70	One large technical room to handle the venitlation zone of the Viking Ship Hall
Storage	36	1	36	Archaeological department (findings, flexible exhibition), Kiosk storage
Cleaning/storage	46	1	46	Cleaning facilities, additional storage
Other	275	1	275	Hallway area, Elevators, Office Entry
Total area (m²)			**4575**	

DESIGN CRITERIA



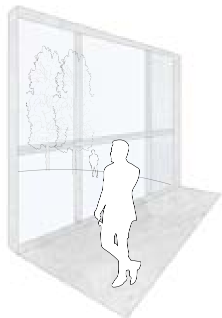
PRESERVING THE SHIPS

Preservation of the five original ships should be of high priority, meaning appropriate environmental controls should be incorporated, as well as placing the ships at least 2.53 m above the terrain, to ensure protection in case of flooding scenarios.



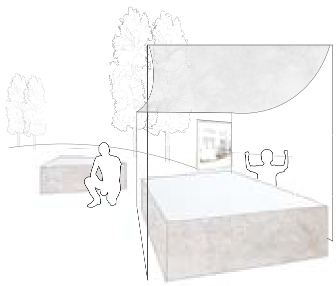
ENVIRONMENTAL CONTROL AND INDOOR COMFORT

An appropriate indoor comfort must be kept throughout the museum, considering both the thermal, visual and acoustical comfort, by implementing suitable strategies, visual connections and proper materiality



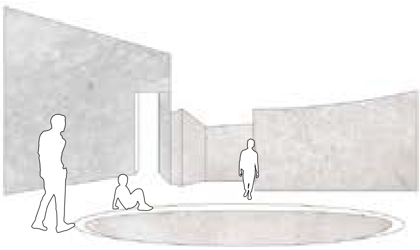
CONTEXT AWARENESS

Prioritize conservation with the surrounding buildings, through overall shape, materiality and landscape adaptability strategies.



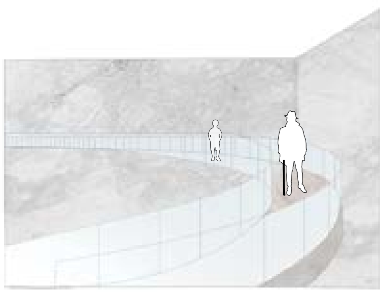
OUTDOOR FACILITIES

Outdoor spaces to showcase temporary exhibitions, events, educational programs, and provide views and spaces for workshops and research facilities



CONTRAST AND SPACE

Enhance visitor experience, by utilizing transitions and contrasts, as well as including seating areas and spaces for relaxation and contemplation.

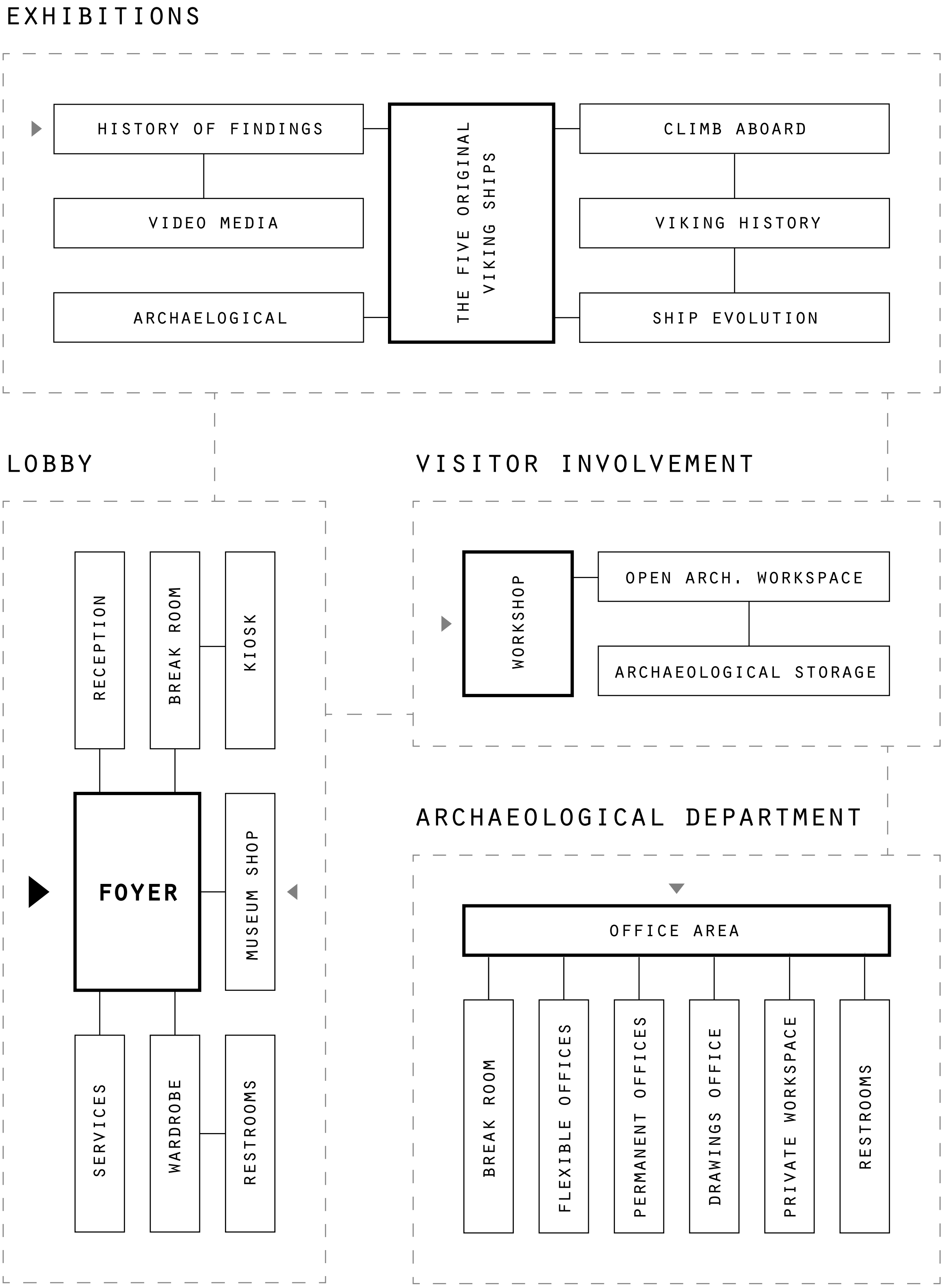


ACCESSIBILITY AND INCLUSIVITY

Accommodate visitors of all ages and abilities, by incorporating clear movement patterns in order to navigate between the different exhibitions.

Ill. 41, design criteria

FUNCTION DIAGRAM



Ill. 42, function diagram

06. DESIGN PROCESS

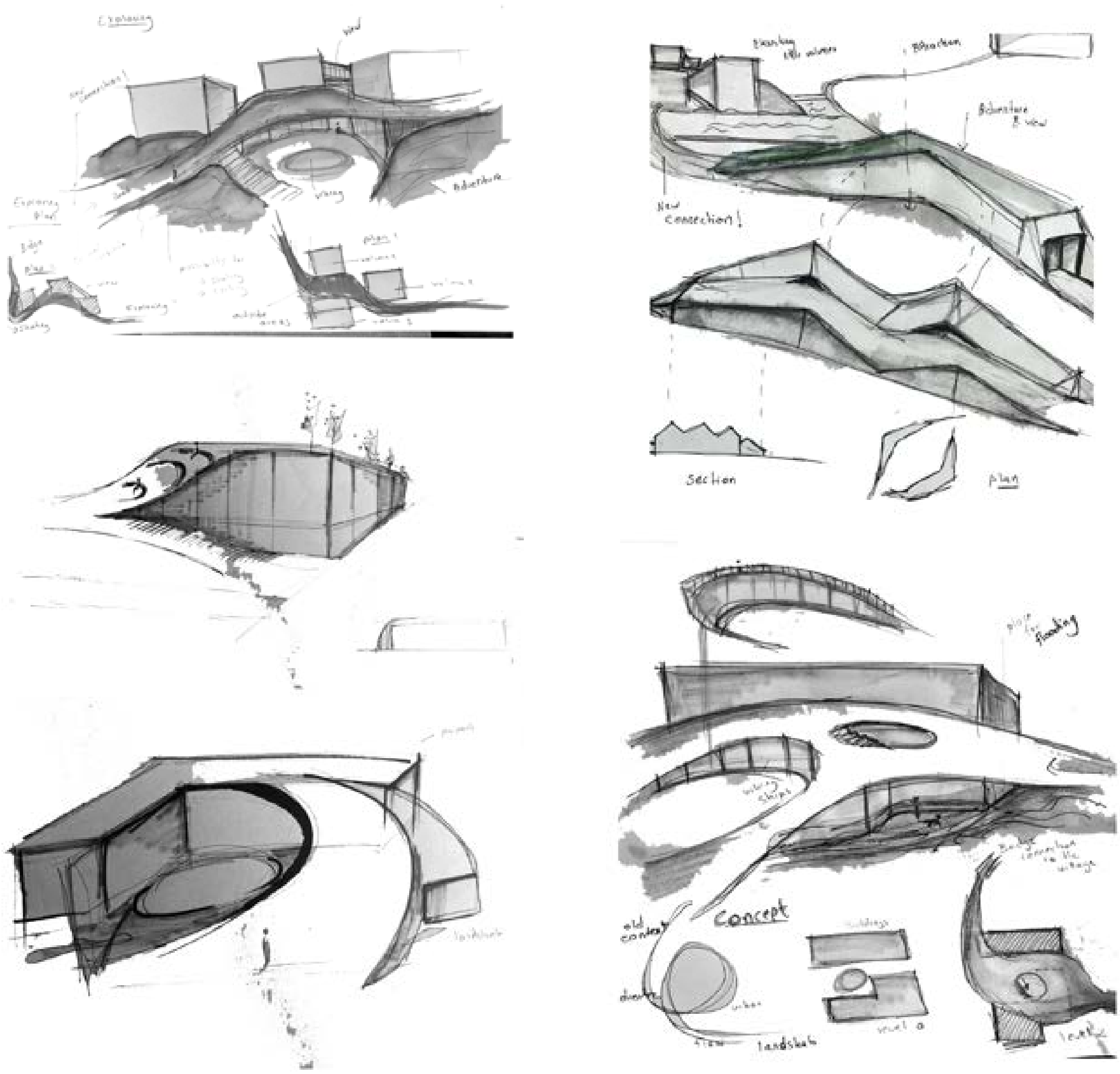
Ill. 43
Photographer: Tiba Adnan

STRUCTURE

INITIAL SKETCHES

INITIAL INVESTIGATIONS

The design process starts out by exploring the first initial ideas and trying out different approaches to investigate different qualities. Many of the first initial ideas included the ability to walk on the roof, or in any way create a coherent transition between building and landscape, to create an experiential process for the public flow. This idea has, however, been dismissed in further investigations due to prioritizing other qualities that made the walkable roof non-desirable. Many of the first iterations were also focused on having a central point as connecting space, and using it as a gathering space with views towards, which is a quality further investigated and developed.



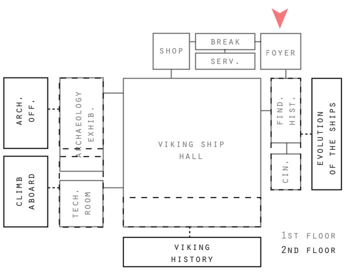
Ill. 44, initial sketches

SPATIAL LAYOUT

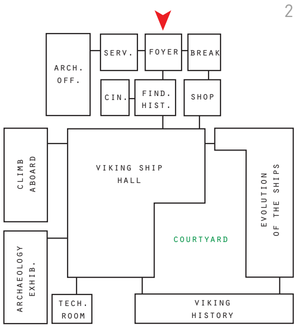
INITIAL INVESTIGATIONS

Furthermore, initial investigations on the spatial layout of the building were included. Before having defined any rooms, different concepts for shape and layout were studied. The initial thought was to have the Viking Ship Hall in the middle, connecting all of the other exhibitions and being the center of attention. When placed in the middle, the hall separates the functions rather than gathering them, which interrupts the storytelling. It also had an impact on the flow pattern and the possibility for outside areas. Furthermore, the desire to create different atmospheres and contrasts in that sense, lead to concept proposals that had curved walls to shape the Viking Ship Hall. The curved walls are considered to encourage movement and exploration, which inspired to work with curved walls for the exterior as well.

Considerations regarding the lighting and atmospheres for different exhibitions were also investigated and explored, as well as how the movement in an exhibition could be. Initial determinations regarding the size of the Viking Ship Hall have been made based on the sizes of the ships, which can be found in appendix 2.

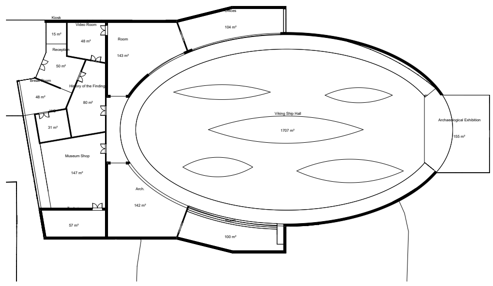


2 FLOORS SPATIAL LAYOUT

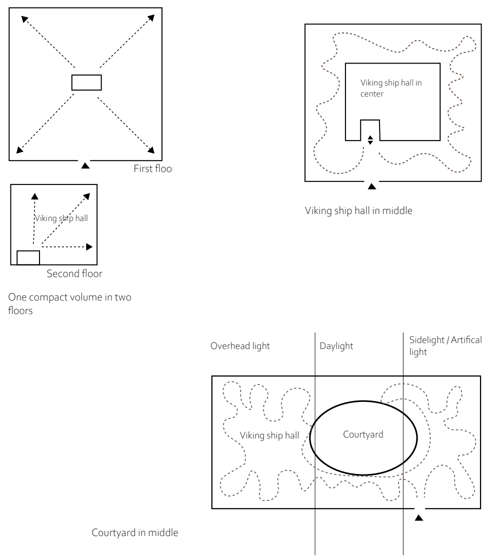


1 FLOOR SPATIAL LAYOUT

STUDY ON EXHIBITION ROOM LAYOUT



ROUNDED VIKING SHIP HALL



SPATIAL LAYOUT AFFECTED BY FLOW

Ill. 45, spatial layout investigations

URBAN PROGRAMMING

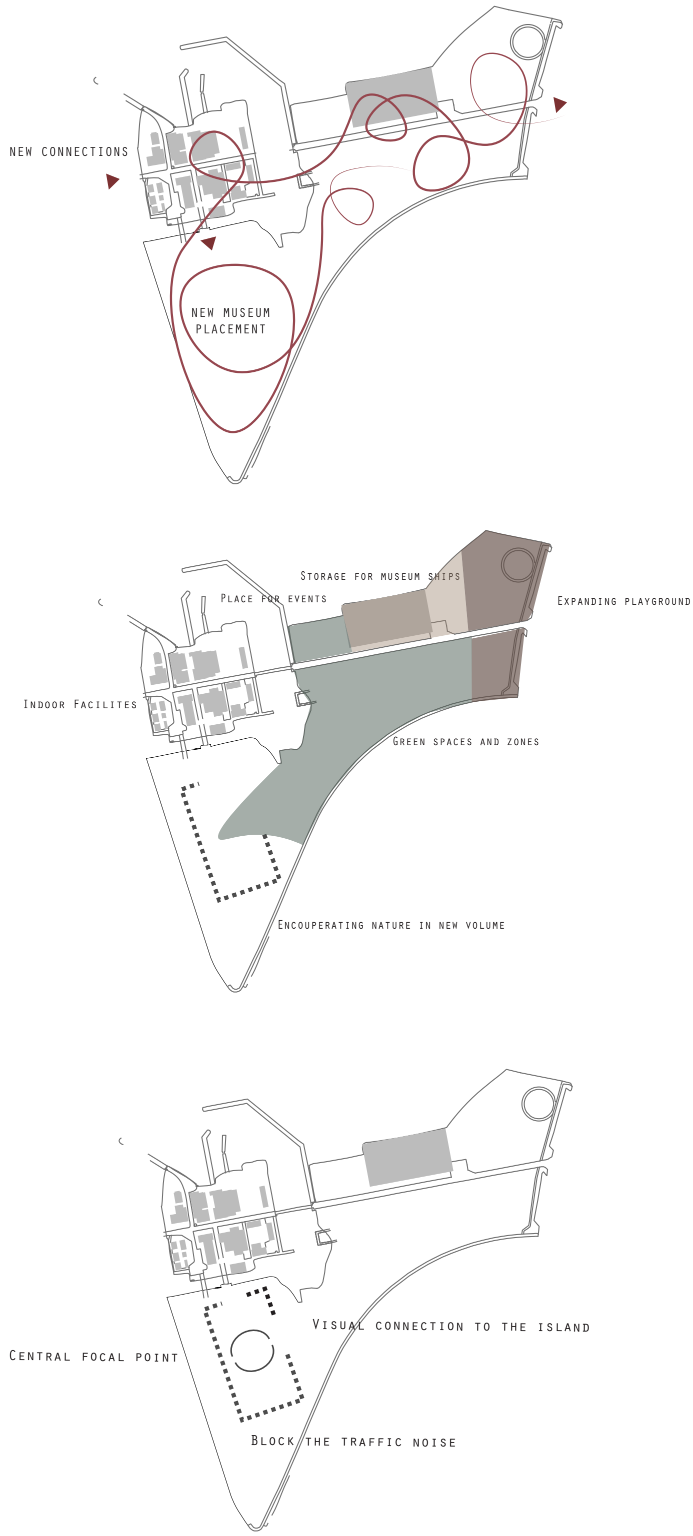
PROGRAMMING OF SITE

The site consists primarily of open green areas that are mostly utilized for car parking and as ship storage. The site programming was therefore an important factor to consider in the very beginning of the design process, to ensure the quality of the urban space around the new volume.

The idea is to transform the old museum into a storage facility, so the reconstructed ships can be protected from weather conditions. In addition to that, some of the green spaces will be kept in order to promote diversity and give space for a mix of cultural events and other activities. These green spaces will include sitting places, different plants and provide a visual interest and in that sense help with leading the visitors towards the outside areas of the new volume.

Based on observations, the little playground to the north-east is utilized by different children and younger people. Therefore the aim is to expand this playground to attract these two user groups to the site.

Moreover, infrastructure such as lighting, bicycle parking and replacing the car parking lot were also considered during the programming. Following are the conclusion of the proposals to accomplish the overall layout of the urban space, which will be incorporated into the final programming of the site.



Ill. 46, urban programming

URBAN FLOW

PROGRAMMING OF SITE

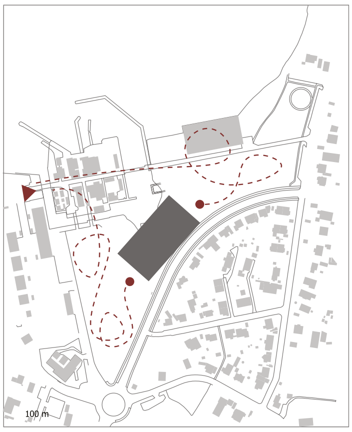
Placement investigations have been made to investigate how the placement and initial shape of the building will affect the urban flow. All of the studies shown are based mainly on making a connection between the new Museum and the existing museum facilities. Based on observations of the site, most people approach the island from the west, therefore this scenario is chosen to further work with.

Moreover, problems such as view and flooding were discussed, which caused a prioritization in the functions according to importance of preservation, and in terms of where the terrain was at its highest to ensure safety of exhibitions during flooding times.

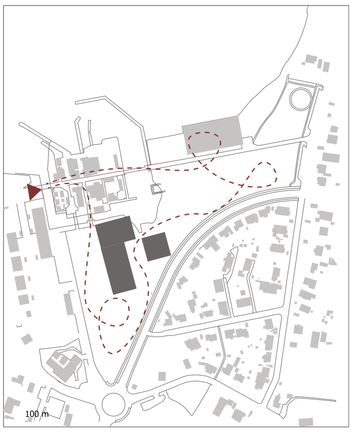
The ambitious room program gave an area of approximately 4500 m2, which is almost double the size of the old museum. If placing this massive volume in the middle, the connection is immediately interrupted. On the other hand, if placing the new volume to the west, a better connection between the three zones is achieved.

Moreover, the level for the terrain in the west is 2,5m which is higher than the rest of the terrain and therefore ensures a better prevention for flooding.

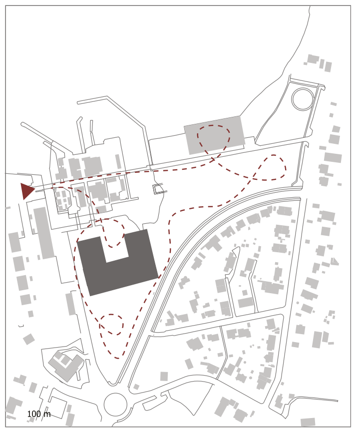
As a conclusion, the placement to the west of the site solves not only the flooding problem but also creates a better connection to the island and the rest of the context.



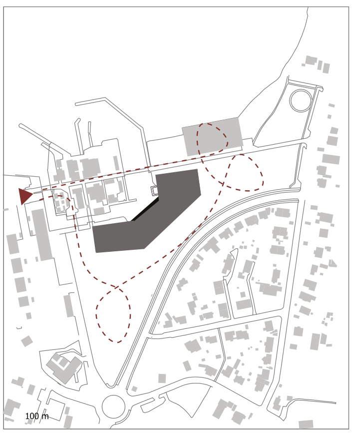
ONE LARGE VOLUME



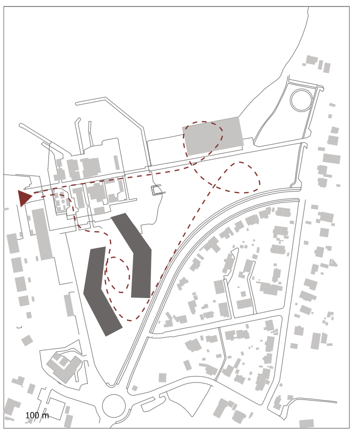
ONE LARGE AND ONE SMALLER VOLUME



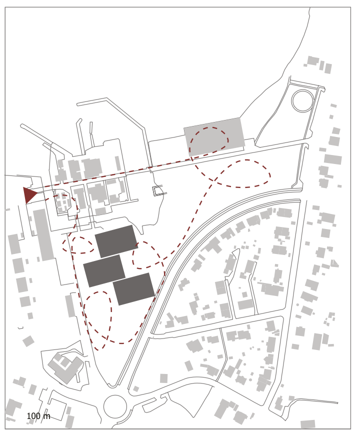
U-SHAPED VOLUME



VOLUMES FOLLOWING THE WATER



SEPARATED VOLUMES



SHIFTED VOLUMES

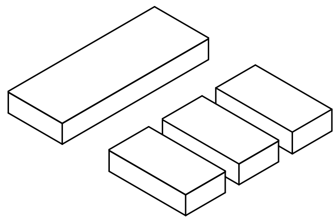
Ill. 47, urban flow

VOLUMES & SHAPES

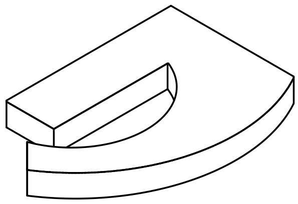
RELATION TO CONTEXT & SCALE

The new Viking Ship Museum will be placed among several different functions, and is situated between the city, the existing museum facilities and the residential houses, making it important to investigate the relation to the surrounding volumes. To the north lies the Museum Island, filled with smaller, separated volumes that are all connected through the outdoor spaces. This type of volume will blend in with its surroundings, but will affect the inside movement, which could be solved by making a central connection point for example by placing the Viking Ship Hall in the middle. A building that would stand out from its surroundings could be defined by curved and organic elements or by a balance between geometrical and organic shapes.

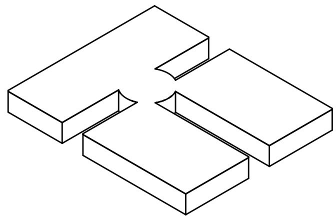
Considering that the surrounding volumes are all defined by geometrical shapes, and that the museum should function as an addition to the existing facilities, a geometrical outline is preferred in order to ensure a relation and connection to the surrounding context.



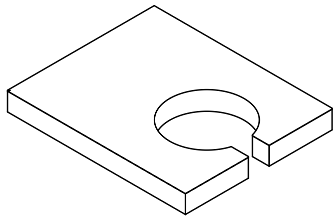
DIVIDED VOLUMES AS THE MUSEUM ISLAND



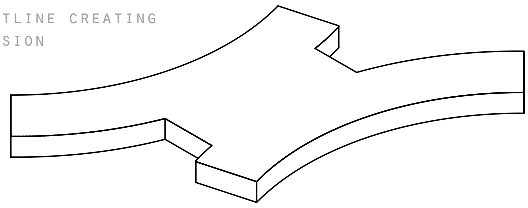
COMBINATION OF GEOMETRICAL AND ORGANIC SHAPES



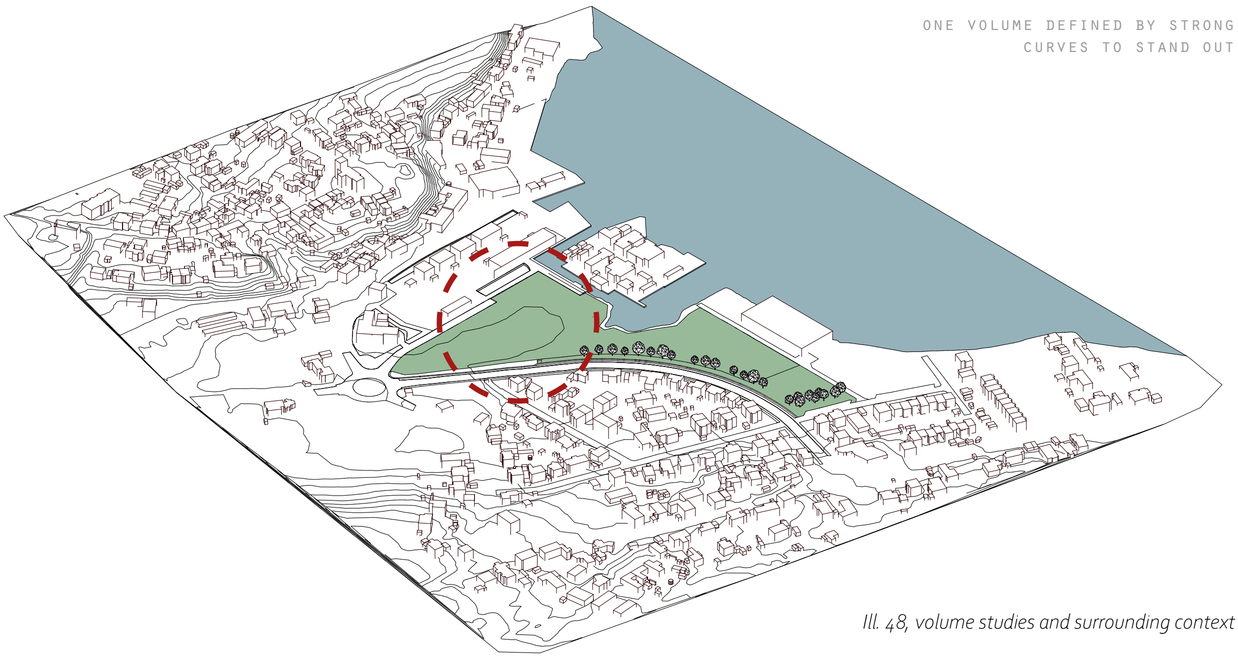
DIVIDED VOLUMES WITH CENTRAL CONNECTION POINT



GEOMETRICAL OUTLINE CREATING MYSTERY EXPRESSION



ONE VOLUME DEFINED BY STRONG CURVES TO STAND OUT



Ill. 48, volume studies and surrounding context

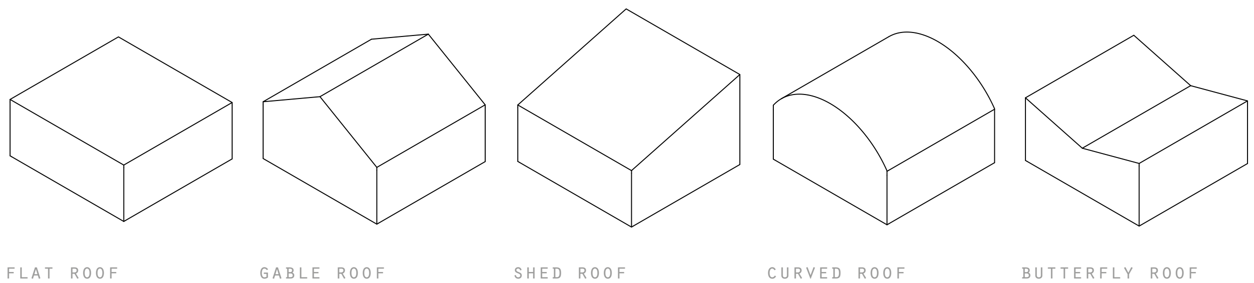
ARCHITECTURAL EXPRESSION

RELATION TO CONTEXT & SCALE

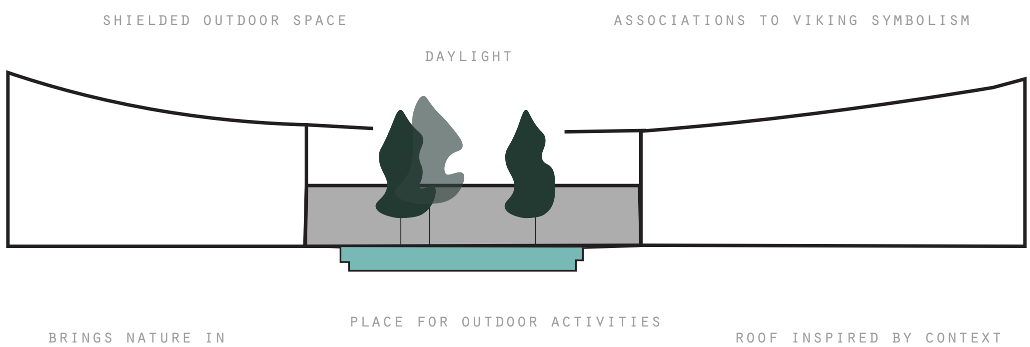
A factor that aids in determining the relation to the scale in the context is considering how the roof is shaped. In the near context there are roof types such as curved roofs, flat roofs, shed roofs and gable roofs. The same roof types have been investigated in this study, to see how each of them affects the building and specifically the overall height, since the building is already considered high due to the sizes of the ships.

The existing museum consists of a flat roof, while the residential houses primarily use gable roofs. The buildings on the Museum Island all have shed roofs, while the administration building west of the site uses a curved roof. To make the new museum differ from the existing facilities, a butterfly roof has been investigated, which relates to the scale in not adding any additional height to the building, as well as it provides associations to viking symbolism in it reminiscing the shape of a ship.

By considering the integration of outdoor spaces, this type of roof allows sunlight to enter as it is lowered in the middle. The overall scale in the context is not disturbed by the roof, making it a natural and symbolic choice as it is inspired both by the context, but also by the artifacts within the museum. The butterfly roof will be used as a roof principle in further design studies.



Ill. 49, different roof types



Ill. 50, roof principle

MUSEUM EXPERIENCE

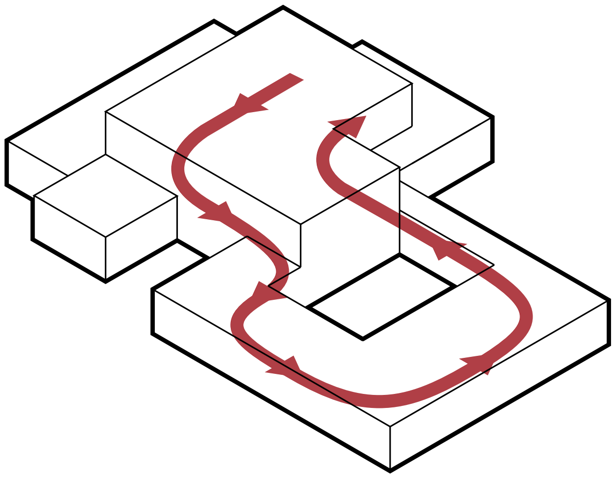
RELATION TO CONTEXT & SCALE

The surrounding volumes differ in height, with the closest ones being two floors. The following study investigates how the different scales affect the museum experience, how the overall expression relates to the scale in the context and how the arrangement of functions impacts the overall shape.

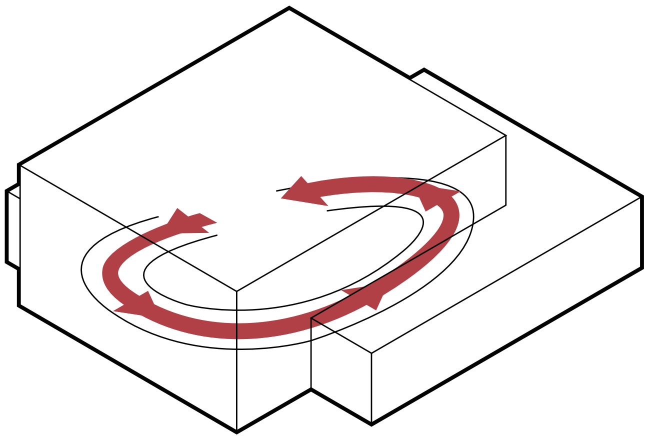
The study explores two different concepts, which consist of one that keeps all of the museum functions on one floor, and another that divides the functions onto two floors. Keeping all of the functions on one floor gives a more controlled and linear flow within the exhibitions, as the visitors are guided through the museum and experience the exhibitions one by one. In this proposal, some of the exhibitions are centered around an inside courtyard, which brings light and activities along.

Dividing the volumes adds to the experience of the museum as it creates a more circular flow where one is guided back to the starting point. It creates a more compact volume that does not stand out as much, as the room height for the ships is balanced by the extra added floor. This is furthermore a way to create different atmospheres on the different floors while also enabling the use of the view.

Further studies going forward will include the integration of a courtyard as it adds to the museum experience by offering outside areas, as well as dividing the functions in two floors, to create a more compact and balanced volume that relates better to the scale in the context.



ONE FLOOR



TWO FLOORS

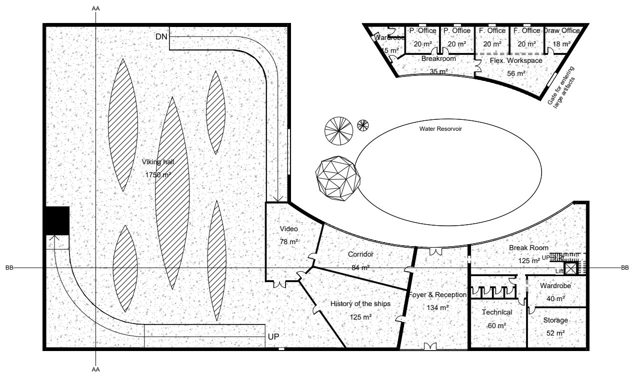
Ill. 51, relation to context and scale considering the museum experience

COURTYARD INTEGRATION

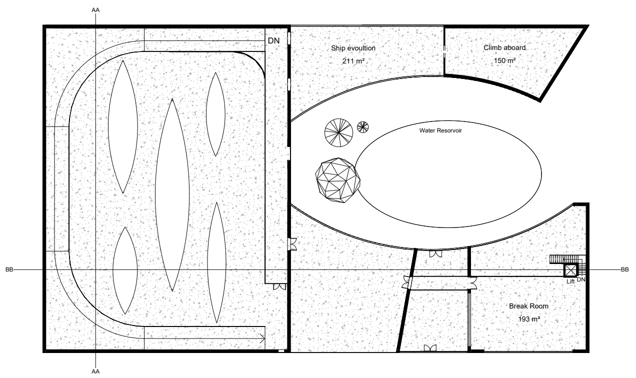
CONCEPT DEVELOPING

Integrating a courtyard is a quality further worked with, and used as concept development. The preliminary concept is to use the courtyard as gathering space and to use it as an active and vivid addition to the museum functions. By integrating the outside areas to the east, it is concluded that the visitor has a better chance of experiencing a natural flow and be invited into the outside area of the museum, which will encourage exploring the museum from inside as well. To ensure the quality in these integrated outdoor spaces, views towards the island/water and implementing seating spaces have been investigated as well.

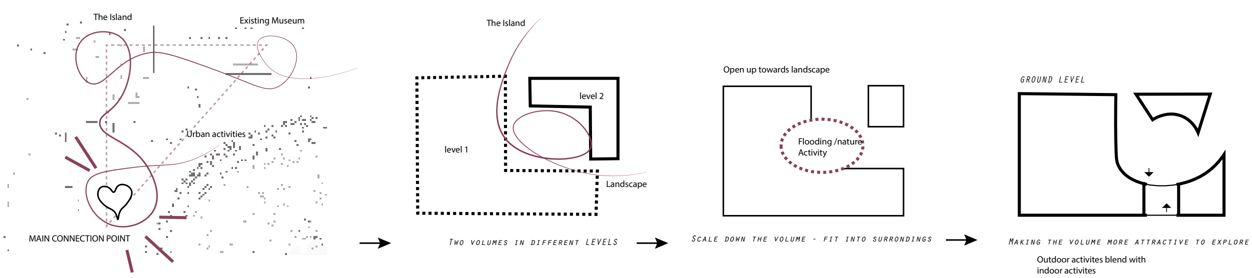
It is concluded that a shielded and secluded outdoor space will be suitable and meet the needs of the guests and activities within the museum. Furthermore, integrating an outside area in the form of a courtyard towards the east will help achieve the desired storytelling of the site programming and the wish to open up towards the surrounding landscape.



FIRST FLOOR OF PROPOSAL WITH COURTYARD INTEGRATION



SECOND FLOOR OF PROPOSAL WITH COURTYARD INTEGRATION



CONCEPT DEVELOPMENT

Ill. 52, courtyard integration and concept development

SHIP PLACEMENT & FLOW

PRESENTING THE SHIPS

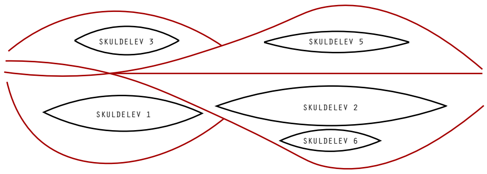
The presentation of the ships is important in relation to obtaining a proper dissemination as well as circulation and accessibility around the ships. A main factor has been to ensure the interest in the ships among the visitors, and therefore create a storytelling experience in the way the ships are presented. The exhibition area containing the ships is the central piece of the museum, and should be presented as such, making the ships form the narrative of the full museum experience.

A variation of setups have been explored to see which qualities and challenges they each possess. The primary focus points have been to explore the flow around the ships, the storytelling experience, the accessibility and how each setup affects the room and the experience.

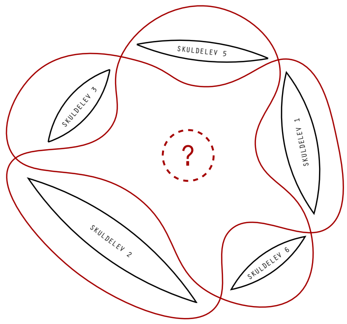
The determining factors have been to make sure that every ship is accessible and possible to see from each side, and that the flow going through them indicates a clear direction on how to approach them while also giving the visitors the option of choosing for themselves how to circulate around them. By creating a flow that circles back and forth between the ships ensures that the visitors stay longer in the room, and therefore maintains their interest. Another important factor was to make sure that most of the ships were visible when entering the room to create a positive overview of them, as well as having a strong concept to the placement in order to create a storytelling experience.

Presenting the ships in the way they were found at the excavation site creates a very clear and strong concept with a history that refers to only these ships. This provides a storytelling experience that can be further utilized in creating an atmospheric experience by enhancing the history even more. It further creates a circulating flow as well as giving access to each ship and maintaining interest.

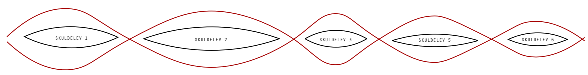
This presentation form gives the strongest concept and will be used in further design investigations.



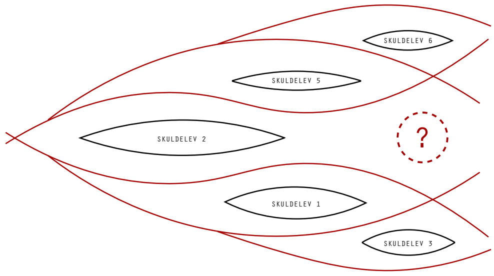
CURRENT PRESENTATION FORM



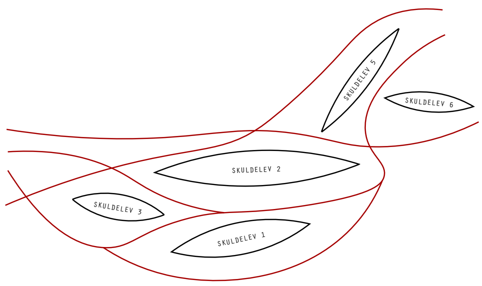
CIRCULAR FORM



LINEAR FORM



FLEET PRESENTATION

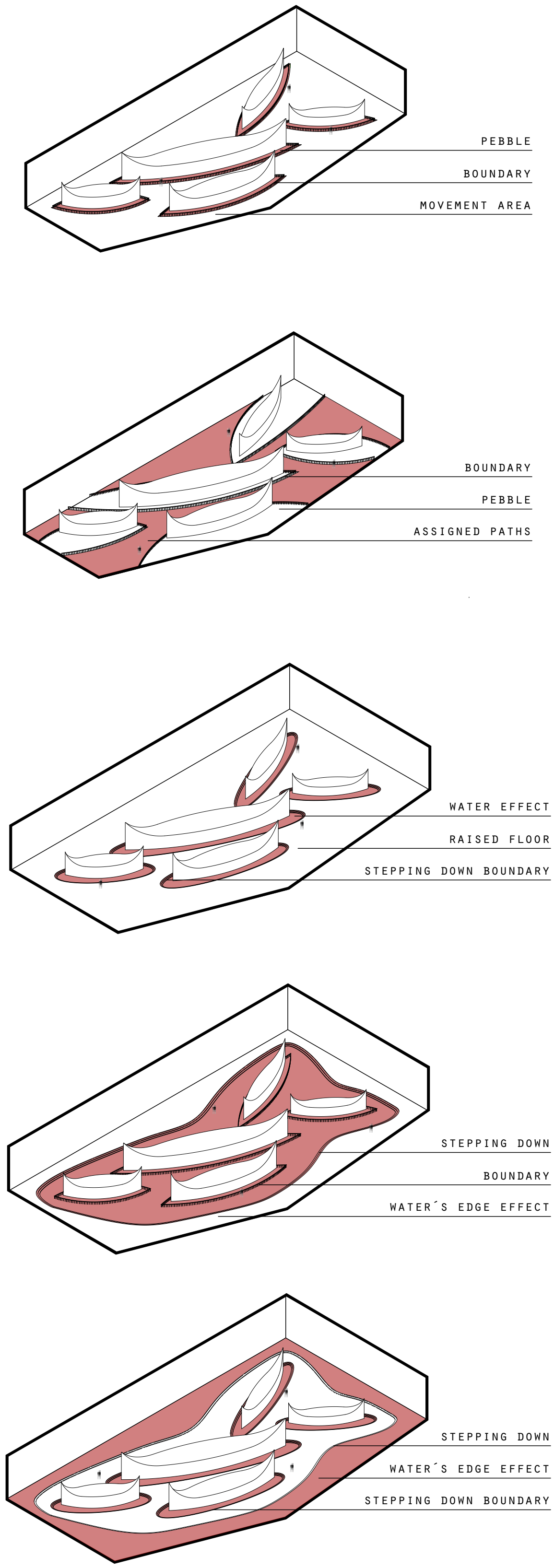


AS FOUND AT EXCAVATION SITE

Ill. 53, placement strategies

SECURITY & BOUNDARIES

PRESENTING THE SHIPS



Ill. 54, boundary effect

Securing the ships is an important part of the viking ship hall, as it ensures a boundary between the ships and the visitors. This study investigates different ways of securing the ships as well as how this affects the experience of them. In the current museum, the ships are secured by a short railing with a framed area consisting of pebble, making sure that no visitors can get too close to the ships.

A similar approach has been explored in this study, where the framed area is defined by the shape of the ships, creating a connected movement around the ships and giving space to explore on one's own. A different approach is to create more strict and determined movement patterns by creating larger framed areas for the ships, which gives the surrounded floor area a more limited movement pattern. These two examples remind of the same atmosphere as in the current museum, as they are both integrating pebble as the framed area.

A new approach could be to integrate the feeling of water in the viking ship hall. This has been explored by utilizing a "stepping down" approach to create the feeling of the ships standing on the water's edge. Using this approach to frame the ships also provides a natural boundary to them, as the surrounding floor area is raised, giving the feeling of standing above the water, while also providing a connected movement pattern. Another approach has been to use the stepping down system to frame all of the ships, to give the feeling of being able to step down in the water to them, but will, however, require a short railing to create the boundary.

Combining these two examples will keep the feeling of stepping down into the water to the ships, while also creating a natural boundary to the ships as well as keeping a connected movement pattern. This approach adds to the strong concept of experiencing the ships, of placing them as they were found at the excavation site, by creating the feeling of water, and therefore, creating an atmosphere reminding of the ships' origin.

VIEW & ACCESSIBILITY

PRESENTING THE SHIPS

ASCENDED

An elevated view of the findings allows for the visitor to experience the ship in an alternate perspective making it possible to have an interior look of the ship. It gives the opportunity to obtain an aerial overview of the exhibition making it possible to gain a combined sense of space of both findings and the hall.

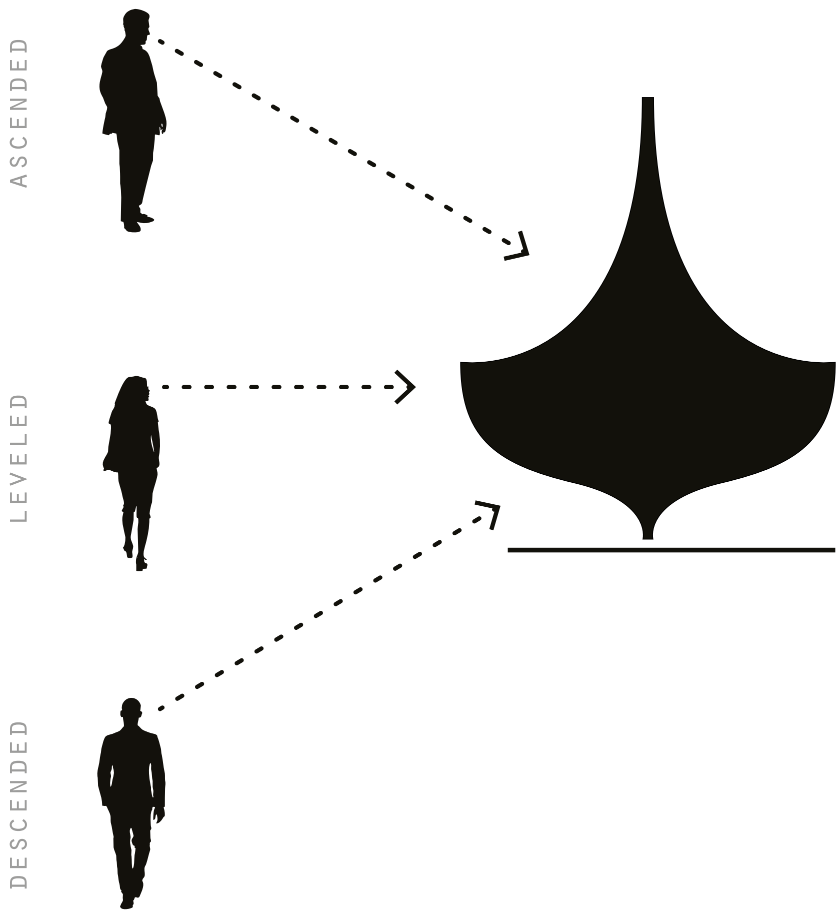
LEVELED

Viewing the findings in direct eyesight clearly communicates their actual sizes and allows the visitor to get real close to the ships and inspect each board of the findings. This allows for a thorough inspection enabling the visitor to immerse in the exhibition.

DESCENDED

Forcing the visitor to view the findings from below enables an alternate experience. As the ships are stable because of assisting rods, the amount of ships visible from a lowered position will be limited. A gentle descent will allow the visitor to experience the hull of the findings but limits the possibility of experiencing the ships together, forcing the visitor to focus on a single ship.

Based on these considerations, it is chosen to create a museum experience allowing the visitor to view the ships in leveled view and in an ascended position to allow for various perspectives of the exhibited artifacts.



Ill. 55, ship visibility

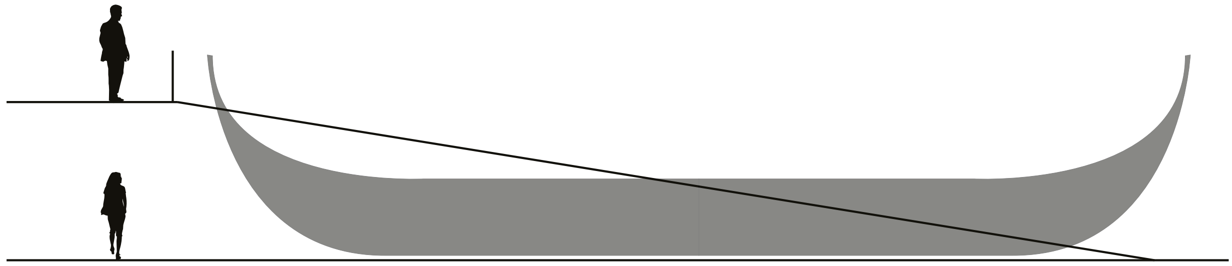
The size of the Viking Ship Hall allows for a two-story access to the exhibition. To create a natural flow in the hall, the levels have to be connected. To do this, the following three methods have been investigated:

STAIRS

Connecting the levels using stairs, allows for an open ground level. The second level will be restricted by the sizes of the ships, however the stairs will limit which visitors will use the connection, forcing wheelchair users to find another way to gain a similar experience. This abrupts the flow of the hall and lowers the importance of the hall that can be gained through mobility.

ELEVATOR

Utilizing an elevator connection allows for wheelchair visitors to easily get to the second level. This enables a clear communication of mobility however the placement of the elevator will be essential for the experience either forcing the visitors among the ships or allowing easy access to the second level, which will be restricted creating a vantage point possible for observing the ships.



RAMP

Implementing a ramp in the hall design allows for easy gradual access to the second level. This makes it possible to obtain a dynamic viewing experience changing as you advance. The ramp serves as a pathway usable for all visitors to use as well as acting as a major element in the museum experience. The ramp can be guided among the ships ensuring constant close connection to the exhibition.

Ill. 56, accessibility and binding element

DESIGNING A RAMP

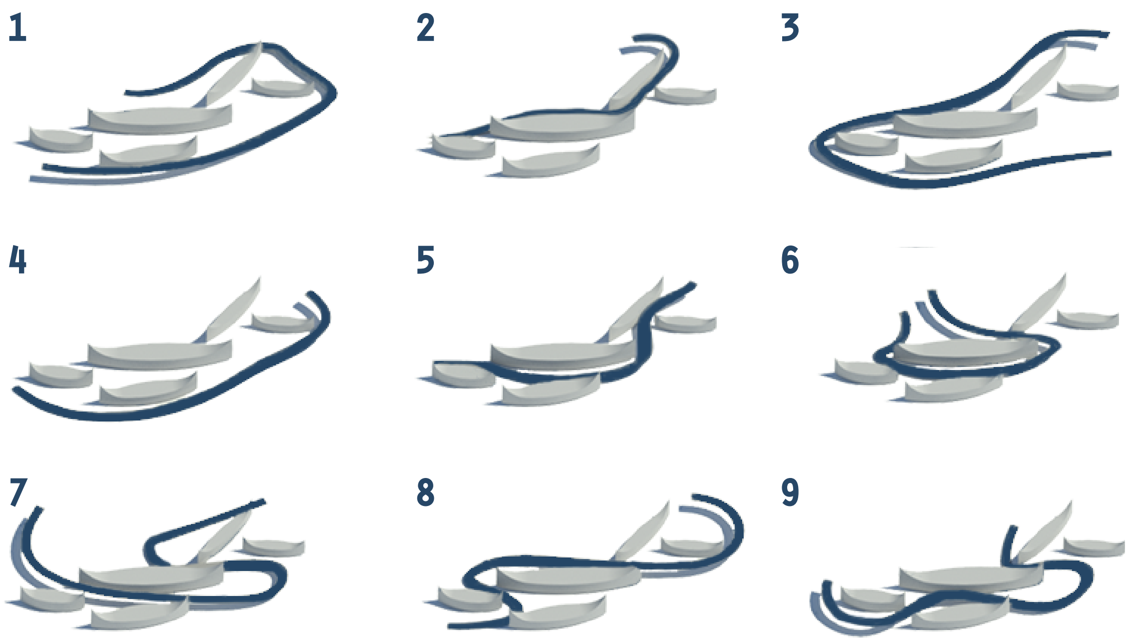
EXPERIENCING THE SHIPS

Based on the previous study, it has been chosen to use the ramp as the binding element of the two levels to create an inclusive and experiencing pathway offering various perspectives of the ships. This choice needs to be investigated further in terms of qualities and limitations, where nine different ramp paths have been studied, each of them designed with specific requirements in mind (appendix 3).

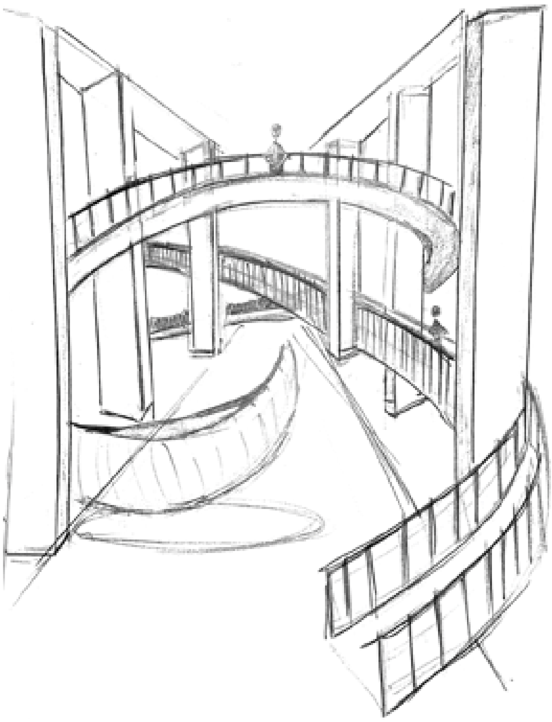
Various paths have been determined having varying spatial feelings with ramps such as 1, 3, and 4 all encapsulating the five ships. These ramps possess a primary function of accessing the second floor with a secondary function of experiencing the ships. There will be a clear understanding of what is important, making the ramp an additional element in the room.

The other ramps forces the visitor to move among the ships integrating the movement to the second level as part of the museum experience making this the primary function of the ramp. These ramps do divide the room where it is important to be aware how to keep the room connected by keeping an open floor plan despite the ramp. However the usage of the ramp making it possible to observe the ships up close on the go from different perspectives gives an experiential quality to the space.

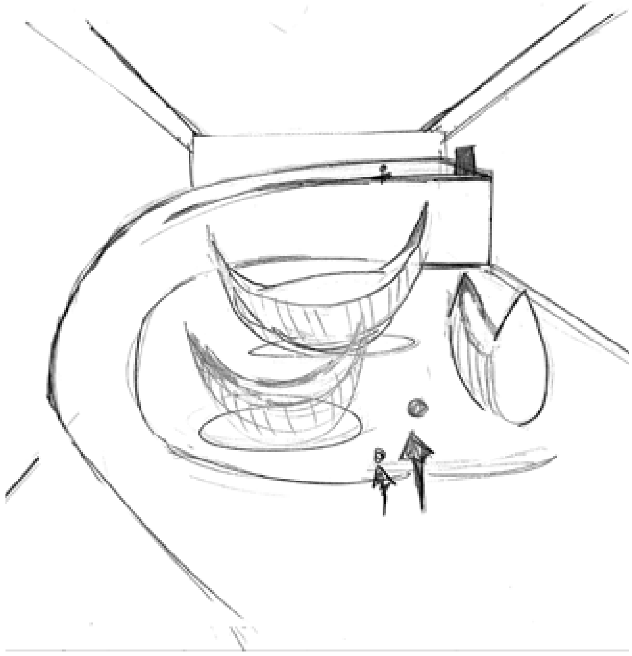
This quality is a lesser priority than the quality of being able to walk close to the ships in the same level, meaning that the placement of the ramp having to go through the space divides the room, which is not desirable. Placing the ramp along the facades is the most desirable choice as this doesn´t disturb the room while still providing the wanted experience of the ships when accessing the second floor. This type of ramp will be used in further design studies and integrated as an experiential element in the final design.



Ill. 57, ramp design investigation

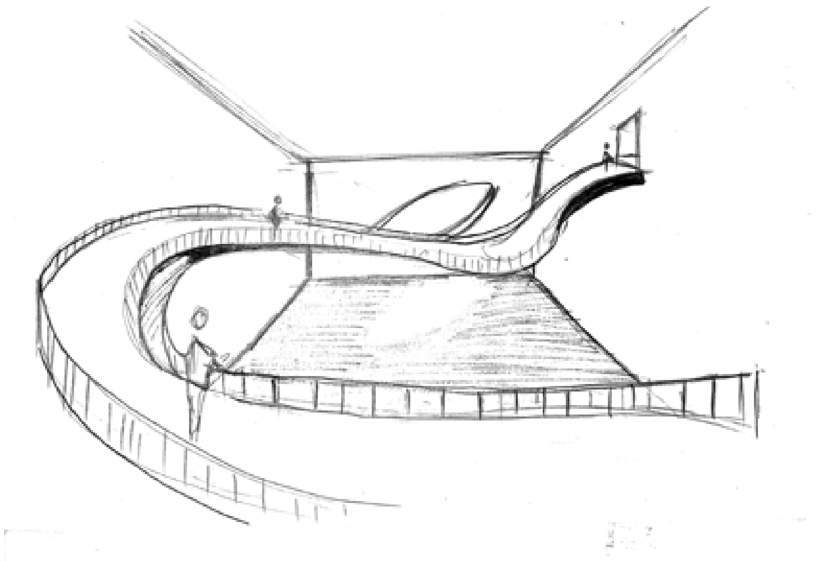


RAMP SURROUNDING THE STRUCTURAL COLUMNS



RAMP EMBRACING THE SHIPS

SPRIALING RAMP



EXPERIENTIAL RAMP CROSSING THE ROOM

Ill. 58, ramp investigations on experience and atmosphere

THE STRUCTURAL SYSTEM

EXPERIENCING THE SHIPS

The atmosphere of Viking Ship hall is investigated through experimenting with different materials, acoustical comfort, structural system and the daylight. The vision here is to create neutral colored background for the five original ships combined with light construction and a good amount of daylight. The challenge is to find a balance between the desired calm atmosphere and the earlier mentioned requirments for this hall.

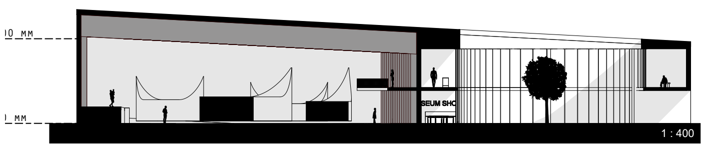
STRUCTURAL SYSTEM

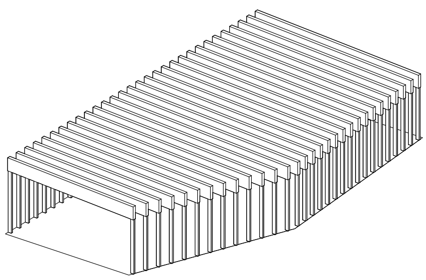
To create a hall with a spacious and airy feeling, the structural system has also been an aspect that was important to consider. Due to the large span, the load bearing elements needed to be calculated while exploring the atmosphere for the hall. In total, there have been three studies on different column and beam designs. The concept of first study, seen in ill. C and D, is to have a simple structural system with big beams.

According to the calculations, (appendix 4), the beams will have massive and heavy dimensions, which will require more columns to carry the load. This in turn will affect the created atmosphere within the hall and make it more segmented and enclosed. The massive beams are also considered to draw attention from the ships, which is the main attraction for the hall.

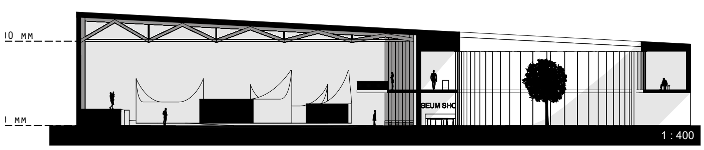
The other concept focuses on creating a light construction, lattice system, as seen in ill. A, B, E and F. The lattice system for beams help achieve the desired light construction affect, and to accomplish this affect there have also been atmospheric investigations on having V-shaped columns, as seen in ill. E and F.

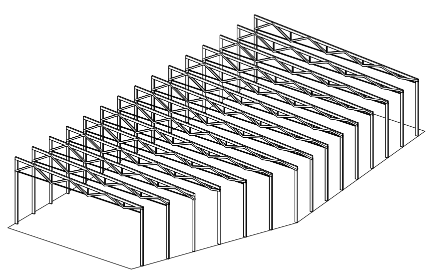
Furthermore, the dimensions and placement of structural elements in these 6 studies have shown to have an impact on the acoustical comfort, which is seen in the illustrations to the right.





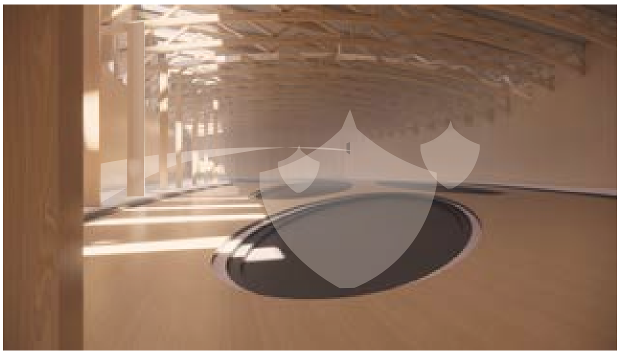
SOLID BEAM CONSTRUCTION



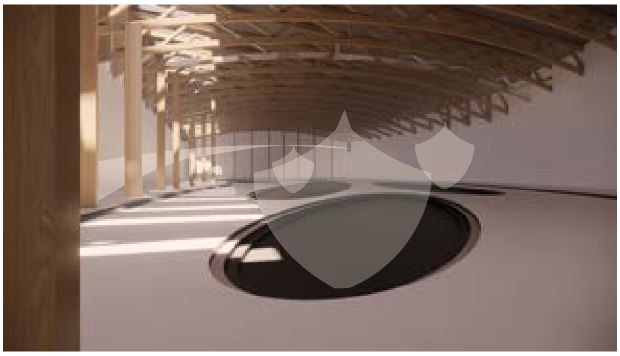


LATTICE TRUSS CONSTRUCTION

Ill. 62, structural system investigations



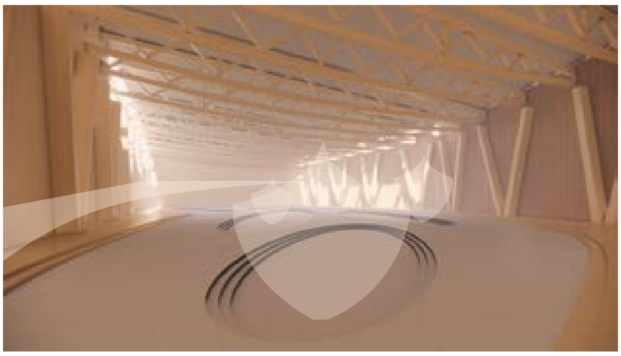
A. TRUSS CONSTRUCTION & WOOD MATERIALITY
REVERBERATION TIME 2.2 s



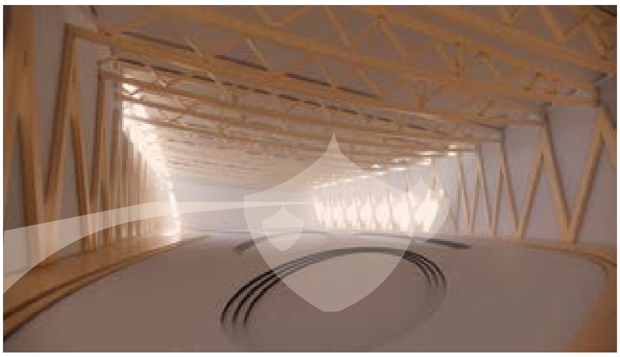
B. TRUSS CONSTRUCTION & CONCRETE MATERIALITY
REVERBERATION TIME 3.4 s

C. SOLID BEAMS & WOOD MATERIALITY
REVERBERATION TIME 1.4 s

D. SOLID BEAMS AND CONRETE MATERIALITY
REVERBERATION TIME 1.9 s



E. TRUSS, V-SHAPED BEAMS & WOOD
REVERBERATION TIME 1.6 s



F. TRUSS, CONNECTED V-SHAPED BEAMS & CONCRETE
REVERBERATION TIME 2.8 s

Ill. 63, atmospheric experience of structural system

MATERIALITY & ACOUSTICS

EXPERIENCING THE SHIPS

MATERIALITY

The primary goal is to find a balance between the desired atmosphere and the acoustical proportion of it. The desired atmosphere is to have a calm expression combined with neutral colors in order to enhance the five original viking ships. This is achieved by studying and visualizing different interior materials along with simulating different interactions of light, window placement and acoustics. There have mostly been focus on utilizing materials like light gray-colored wood and unfinished concrete. The initial thought was to work with concrete for the hall, in order to make the ships as the main element of focus. After calculating the acoustics, one realized that the achieved reverberation time is at the highest when choosing concrete as interior cladding.

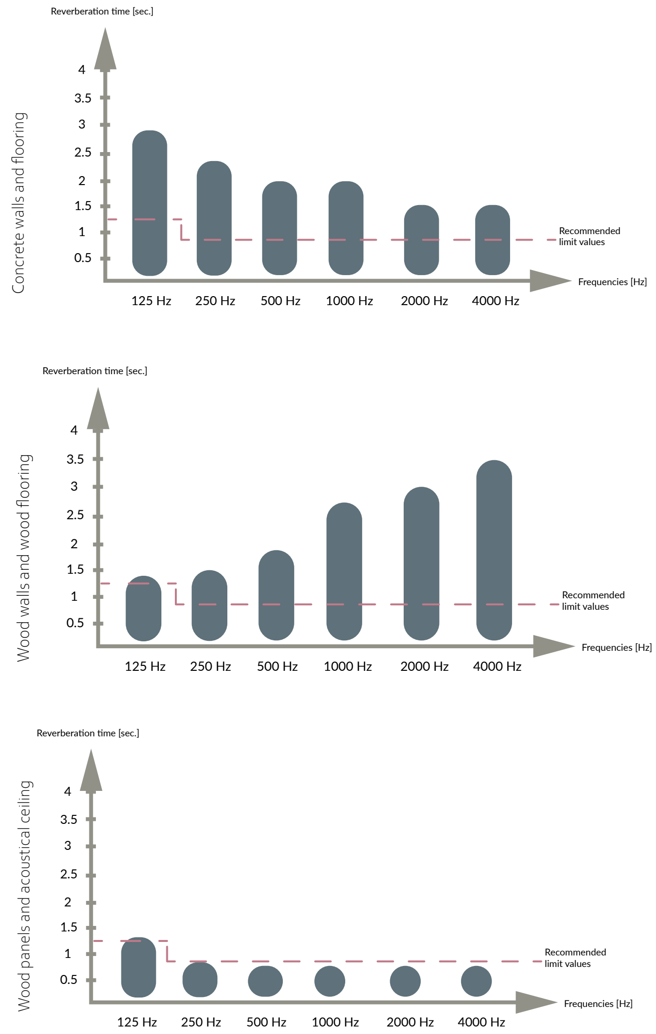
ACOUSTICAL COMFORT

In terms of acoustic comfort, the Viking Ship hall is estimated to be the most critical room due to its large surface areas and height. Therefore, an examination of the acoustical comfort was closer studied through both reverberation time calculations but also ray tracing simulations.

This investigation was ongoing along with the earlier mentioned structural studies, to ensure that the chosen interior materials and room shape supports the acoustical comfort.

REVERBERATION TIME

The process started by making calculations on reverberation time for different materials, along with the earlier mentioned studies for daylight and structural systems.



Ill. 59, acoustical results

The reverberation times in different frequencies were calculated through Sabine's equation (appendix 5) before and after the ceiling lamellas were implemented. According to Commercial Acoustics , the reverberation time for a big hall is supposed to be maximum 1.3 s.

To activate this reverberation time, little beams will be added to the ceiling in between the bigger load-bearing beams. The dimensions of these lamella are further worked with and simulated in Grasshopper, pachyderm plug-in.

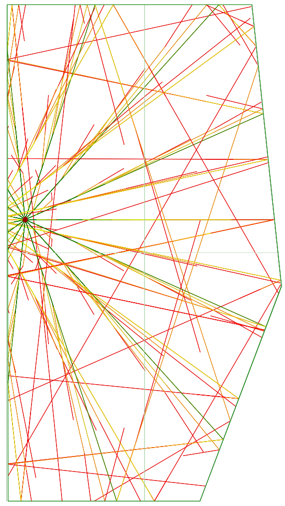
RAY BOUNCING

The difference between before and after the implementation of ceiling solution is seen in ill. A and B. This scenario is based on one directional sound source (a human) that is visualized by rays that are chosen to only bounce four times. The more the sound bounces the more energy it loses. In this case, the green bounce is the first bounce and the strongest (have the most energy), meanwhile the yellow is the second bounce and orange and red are the third and fourth bounce and are in this case the weakest. The aim here is to implement a ceiling solution that captures the rays and makes them bounce to lose energy and scatter the rays. This will further be combined with having absorbent surfaces on walls, as close as possible to the sound source.

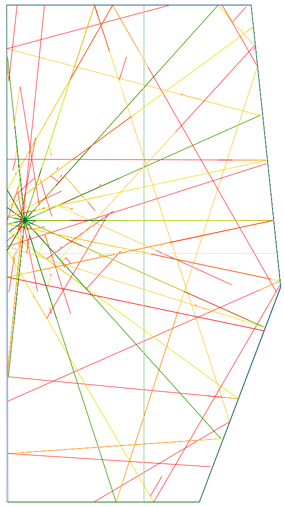
This is initially investigated firstly by making four different niches for lamella, to study which one is more effective when it comes to ray bouncing. It's concluded that the deeper the niche is, the more the sound can bounce inside, as seen in ill. 61.

By combining both absorbent and diffuser surfaces, the sound rays will be weaker and scattered in different directions which will give a better acoustical comfort with the designed environment. The chosen design for the acoustical ceiling solution is achived by working with deep wood niches, that are close in expression to the wall lamella,in which will be implemented between the bigger load-bearing lattice beams. The dimensions of these beam nisches are 0.3 m in length and 0.1 m in width.

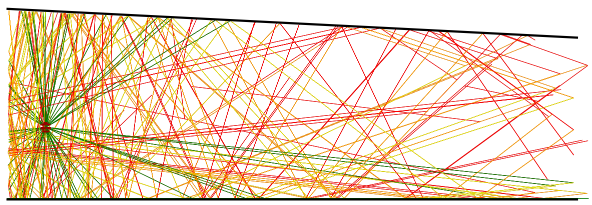
As seen in ill. 60B, these diffuser beam niches help scatter sound rays in different directions, which is considered to reduce the impact of standing rays and create a more natural listening environment. In addition to that, there will be worked with wall wood-lamella that have absorbent layers in between to create a combination of absorbent surfaces and scattered ones.



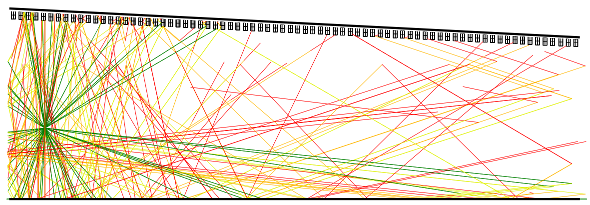
A. PLAN VIEW - BEFORE



B. PLAN VIEW - AFTER



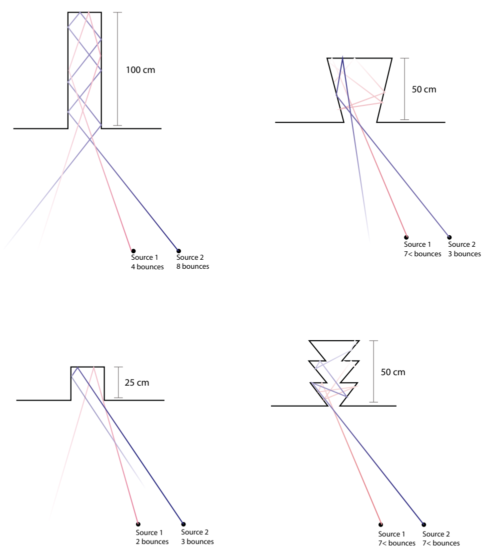
A. SECTION VIEW - BEFORE



B. SECTION VIEW - AFTER

first bounce *second bounce* *third bounce* *fourth bounce*

Ill. 60, ray bouncing



Ill. 61, ray tracing experiments

DAYLIGHT & ILLUMINATION

PRESERVING THE SHIPS

The Viking Ship Hall requires a very controlled indoor environment where a maximum value of 1500 lux hours on the ships must be complied. However, in order to create a pleasant experience for the visitors of the museum, it is investigated how to structure the window placement and dimensions to ensure daylight into the large hall.

THE VIKING SHIP HALL INDOOR ENVIRONMENT REQUIREMENTS	
HUMIDITY	40-55 %
TEMPERATURE	18-23 °C
LIGHTING	max. 1500 luxhours pr. 24 hours
RADIATION	as close to 0 ug/lumen as possible

Table A, indoor requirements regarding the viking ship hall

THE NORTHERN FACADE

The first investigation studies the placement of windows on the northern facade, where the initial studies are based on 10% and 20% window-floor ratio with different window placements, to ensure that the lux levels don't extend 1500 luxhours. Natural light is integrated and investigated due to the vision of incorporating daylight as part of the exhibitory experience, and to give the visitors an opportunity to visually be connected to the island to the north. Commonly for these windows are that the height of the windows are 2 meters, but the width varies, which is seen to provide different results.

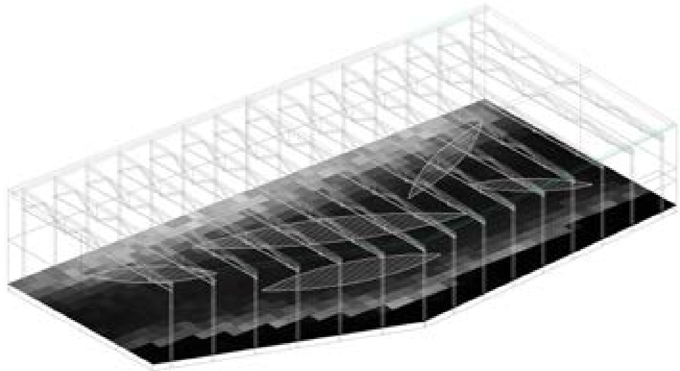
THE ROOF

The roof has also been a part of the daylight investigations to study how placing windows here will affect the overall atmosphere and experience. Overhead lighting is investigated to accentuate the five original ships and to create depth and dimension within the hall. The vision is to utilize the daylight to enhance the transitional spaces, encouraging the visitor to not only walk on the ramp but experience it as well. This led to investigating the effect of placing small windows on the roof, to figure out if this placement would harm the ships.

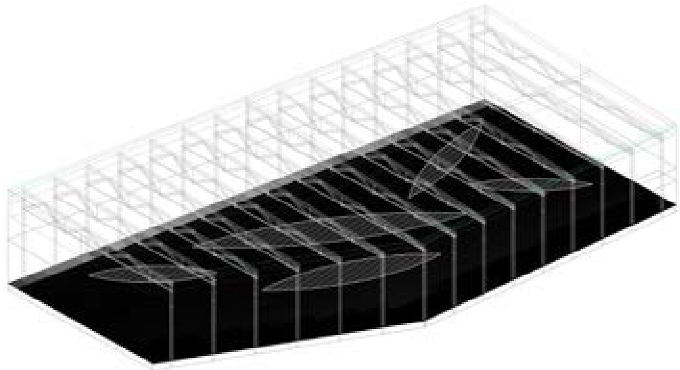
As seen in the results, the daylight level is above the allowed amount, making this solution damaging to the ships.

Considering that this solution is still desirable, further investigations were made, to figure out what impact the structural system would have on the amount of daylight entering the hall.

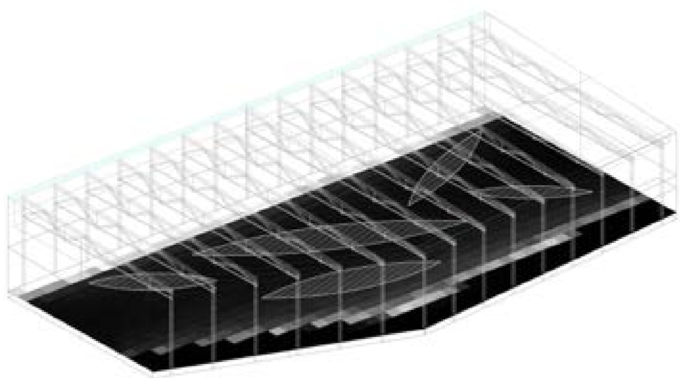
Ill. 64, initial daylight investigations



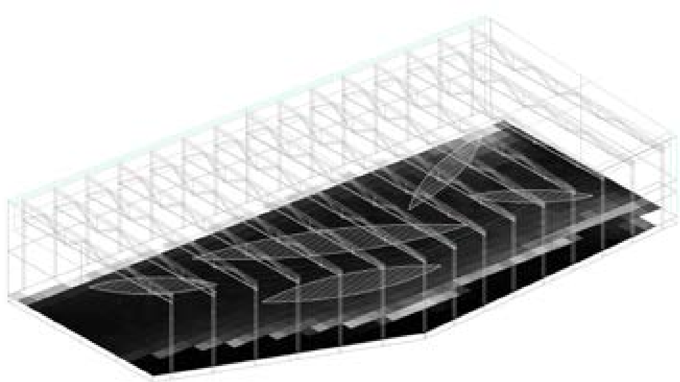
Ill. A: *0,5 m window height on each side of roof*



Ill. B: *0,5 m window height on roof - suspended ceiling*



Ill. C: *1,0 m window height on roof - suspended ceiling*



Ill. D: *1,0 m window height on roof with northern windows - suspended ceiling*

Ill. 65, additional daylight investigations

Initially, investigating the effect of placing a small row of windows on each side of the roof, ill. A, it is ensured that the transitional spaces of the ramp and balcony are lit up by daylight without causing danger to the ships.

In order to create more directed daylight onto the transitional spaces, the roof structure is enveloped in a suspended ceiling creating light-wells on each side of the hall deliberately lighting up these areas, ill B. The size of the windows limits the amount of daylight entering the hall.

Increasing the window sizes makes a more direct distinction between transition and exhibition with each side being affected by daylight on a larger area than the previous iteration without danger to the ships, ill. C.

The potential of these clear distinctions were further investigated as the window sections were expanded downwards the north facade creating a bond through the Viking Ship Hall allowing for views towards the island on either side of the room introducing the surrounding museum area as a background at certain points of the exhibition, ill. D.

The results conclude that this solution does not cause any harm to the ships, making this quality further implemented in the project as the experiential qualities and the ship affection of this iteration is favorable, creating a difference of the two zones in the Viking Ship Hall.

INDOOR ENVIRONMENT

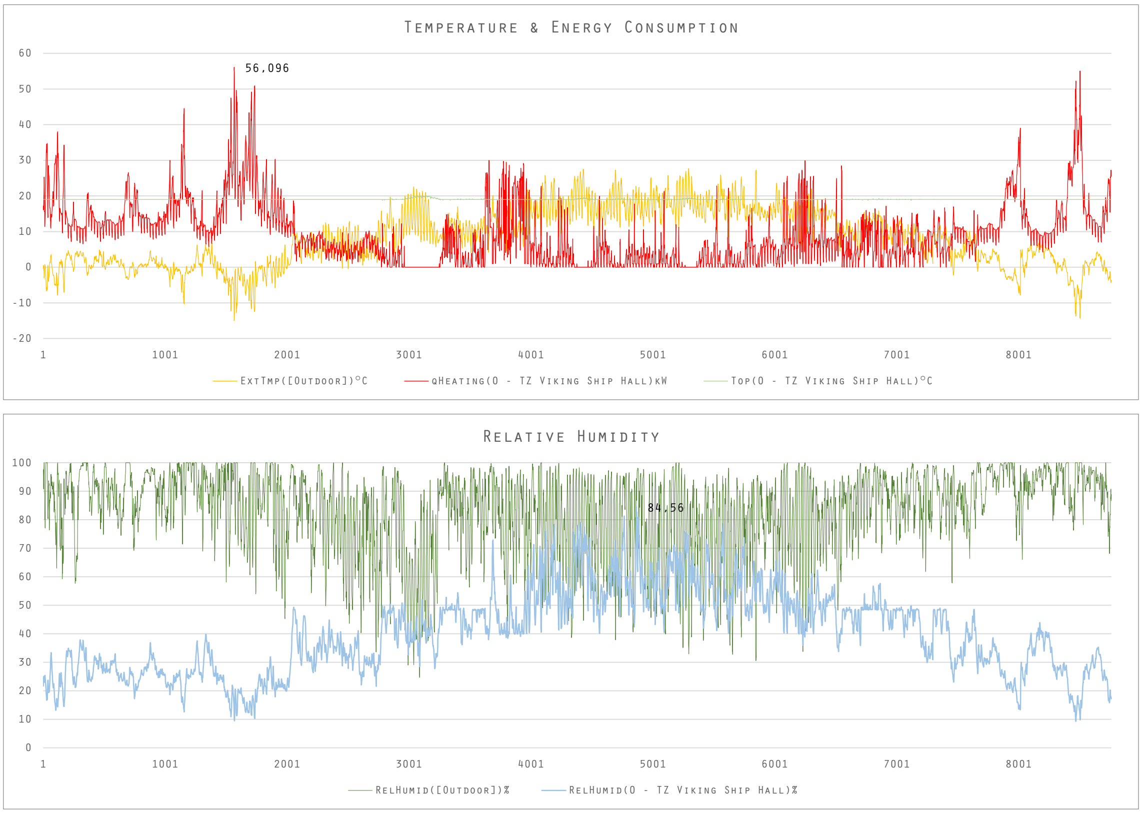
PRESERVING THE SHIPS

Preserving the ships is the main theme for establishing a new museum. By investigating the indoor environment through BSim-simulations, all requirements can be studied as to how they work in this design. These values are presented in table (A).
As the room must abide by these values various systems can be put in place while ventilation air flow has been calculated, resulting in following:

THE VIKING SHIP HALL INDOOR ENVIRONMENT REQUIREMENTS	
HUMIDITY	40-55 %
TEMPERATURE	18-23 °C
LIGHTING	max. 1500 luxhours pr. 24 hours
RADIATION	as close to 0 ug/lumen as possible

Table A, indoor requirements regarding the viking ship hall

VIKING SHIP HALL - GLAZING

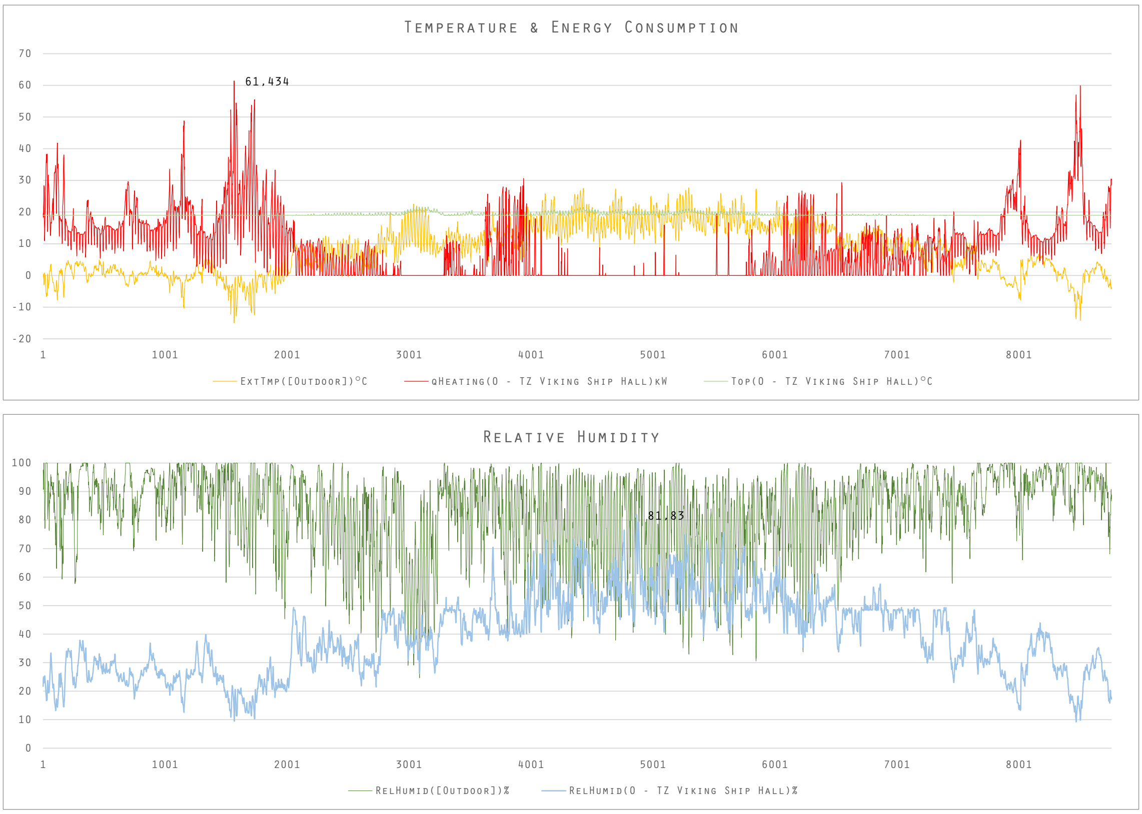


Ill. 66, Bsim results with glazing

The initial simulation shows that the temperature values are stable throughout the year as a result of an active heating system keeping the temperature at a value around 19 degrees celsius which is obtained as a combination of the ventilation and heating. With the initial systems in BSim the heating reaches a peak value of 62 kW to counteract the outdoor temperature.

The relative humidity of the hall shows to be an issue. This value is required to be limited to values between 45%-55%. In wintertime, the lowest percentage reaches 10% and reaches a highpoint at 82% during summer, values greatly deviating from the limits. The low temperature during nighttime raises the relative humidity level of the outdoor air, which affects the humidity level in the indoor environment as well and will be investigated.

VIKING SHIP HALL - HUMIDIFYER



Ill. 67, Bsim results with humidifyer

The issue of the indoor environment is clear to be the large variety of the relative humidity in the Viking Ship Hall. This led to further investigating different system setups in BSim to obtain the required humidity values.

This led to various setup of heating, cooling and ventilation intensity in addition to the addition of a humidifier in the hall. This impacted the results in a positive direction raising the lower values to a more acceptable level. With the impact of the other systems the indoor environment values changed to interesting results.

Due to the application of the humidifier, the ventilation system was adjusted resulting in a lower peak value, though an increase of activity in summertime. The adjustments of the ventilation helped stabilize the relative humidity levels throughout the year. Compared with previous values, the humidity of the Viking Ship Hall appears more coherent, raising the low humidity level to 30 %. Looking at the graph the humidity level seems to appear on average about 50% as the humidifier is active. The active period has been established as continuous usage would raise the humidity level during summer even further.

This investigation shows that the desired solution for the indoor climate is to establish humidifiers in the hall ensuring a more stable indoor environment. This study serves as a stepping stone for the direction of the design.

ATMOSPHERIC EXPERIENCES

ADDITIONAL PROGRAMMING

In addition to the Viking Ship hall exhibition, the room program has other smaller exhibitions that stand as a contrast to the big, open and lightened up hall. Most of these exhibitions will have gypsum as their interior wall cladding. The main goal for these exhibitions is to create a variety in atmospheres through incorporating a variety of media and technologies to engage visitors and communicate information about the viking age. Each one of the exhibitions will revolve around exploring a particular topic. Some of these are :

ARCHAEOLOGICAL EXHIBITION

The purpose here is to create an underwater feeling, where the general atmosphere is dark, relaxing and has blue as a dominant color displayed on walls, ceiling and touchscreens. Here the underwater elements will be showcasing artifacts from shipwrecks and other underwater sites.

HISTORY OF THE FINDINGS

The flooring of History of the findings is directly inspired by how the ships were found. Here the visitor can experience the history behind the excavation, and learn of the ships' origin. Wood will be utilized for the wall cladding, to create an atmosphere resembling the excavation site, which ultimately creates the feeling of standing in the excavation site, exploring the five Skuldelev ships.

CLIMB ABOARD

The aim here is to provide a climbing opportunity onto a boat or ship for a tour or excursion for both children and adults. The atmosphere is considered to be exciting and allows participants to see and experience things from a unique perspective. Most of the implemented activities will not be physically challenging to be more suitable for children from all ages.

VIKING HISTORY

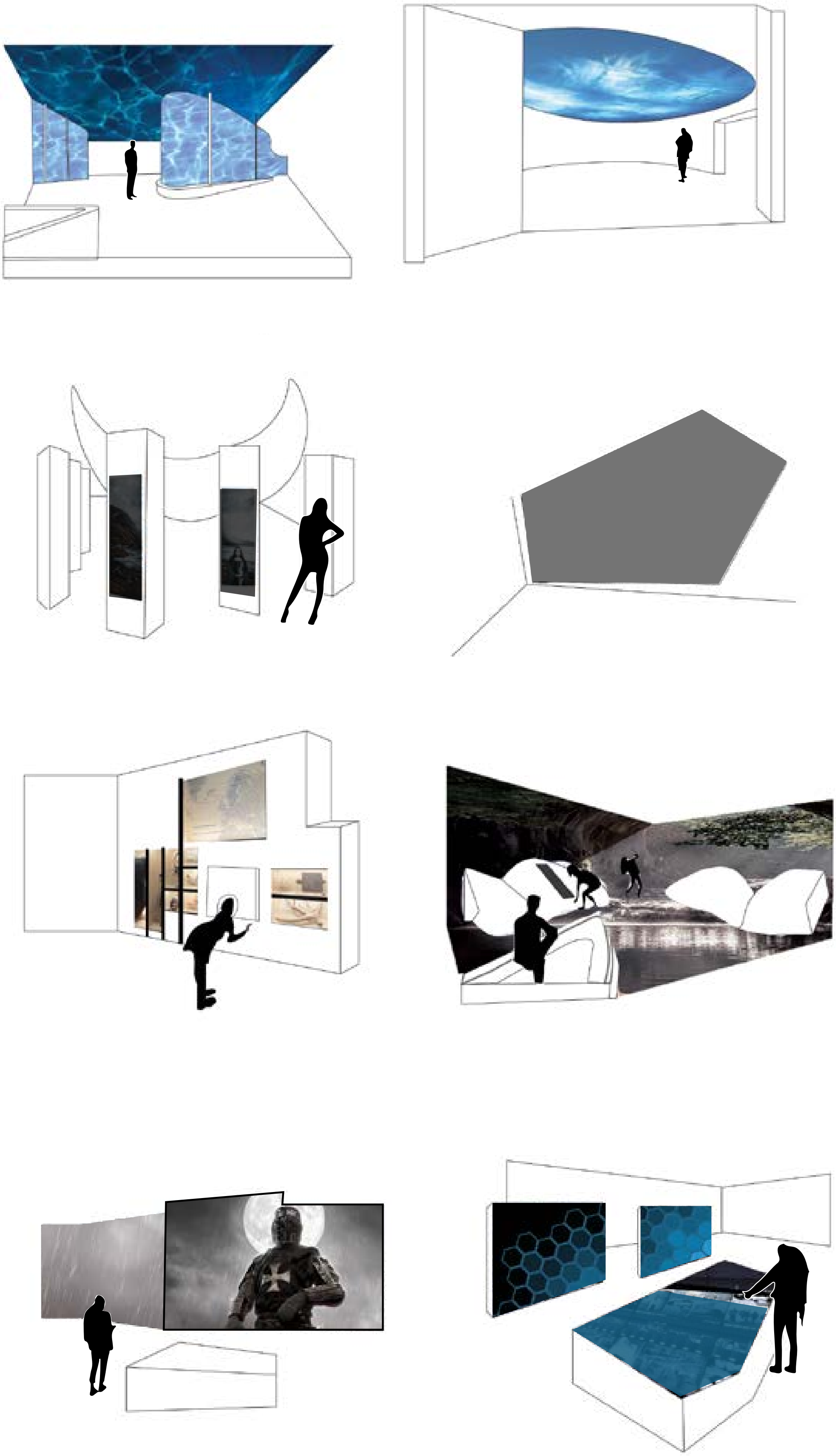
The vision is to create a design of customized display tables that have a color scheme connecting the tables with the flooring material. This exhibition will provide a view into the past and allow a better understanding of the viking environment and challenges.

ARCHAEOLOGICAL

HISTORY OF FINDINGS

CLIMB ABOARD

VIKING HISTORY



Ill. 68, atmospheric experience in additional exhibitions

PLACEMENT OF FUNCTIONS

ADDITIONAL PROGRAMMING

Having defined the Viking Ship Hall and the wanted atmospheric experience in the additional exhibition rooms, the complete plan solution was investigated. From previous studies it was concluded to integrate a courtyard in the eastern part of the building, as the Viking Ship Hall would be placed to the west, to accommodate the context related buildings. This courtyard would be the determining factor in how to place the functions, as it divides the building when being placed in the middle.

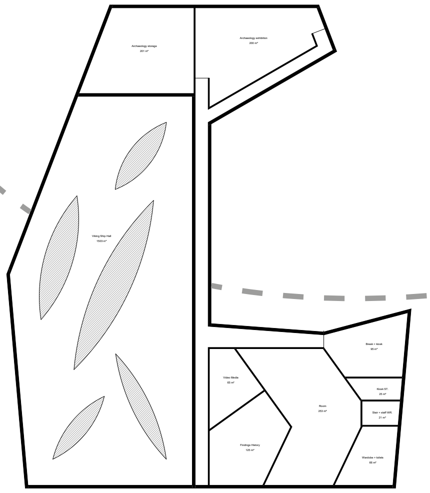
Before the investigations were made, some initial requirements were concluded, such as having the archaeological department close to the archaeological exhibition, having the History of Findings as the first exhibition before entering the Viking Ship Hall and having the courtyard be an open space embraced by an inside hallway to always keep the connection from inside and outside.

The first iterations were defined by the outline of the Viking Ship Hall, which gave an outer shape formed as a hexagon. The courtyard shapes a hallway area along the facade, making the additional functions divided, and with the entrance area to the south. This is also the case with iteration 3 and 4 that also tries to create shifted volumes to create a clear indication in the separation of functions; the Viking Ship Hall in one part of the building and the other functions in the other part of the building. The inside hallway area is also present in these two iterations, where the courtyard is defined as respectively a square and a pentagon. The outline of the Viking Ship Hall forms a clear geometrical shape, which is concluded to be desirable, and developed further upon.

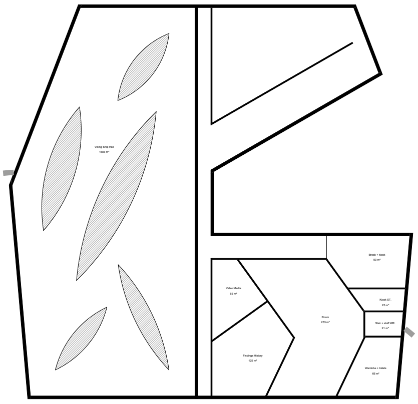
The last two iterations have transformed the courtyard into a circular form to make it a more pleasant place to be, and to integrate the inside functions better. The entrance area has been moved to only being accessible from the courtyard, to create the feeling of the building being a mystery box, to make people interested in exploring and visiting the inside. This is also creating one clear entrypoint through the opening in the building, which has a high quality in also embracing the courtyard and making it more intimate and non-disturbed.

The functions are placed to have the archaeological exhibition to the north, as well as the archaeological department placed on the second floor. Having the History of the Findings as the first exhibition creates a transition from a small, closed and semi-dark room to a large, open and historical room when entering the Viking Ship Hall. The entrance and the additional functions connected to this area are all placed towards the courtyard, ensuring views to green and vivid spaces and allowing daylight to enter.

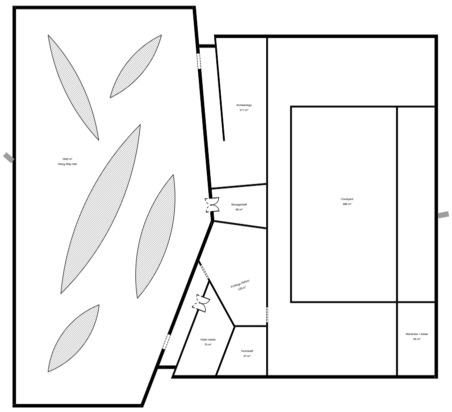
During this study, it was discovered that the butterfly roof was adding too much room height on the second floor, which caused the rooms along the eastern facade to have too much unused space, which was not desirable. To maintain the expression and the connection to the context, the roof expression was altered to only have a slope to one side, transforming it into a shed roof instead. This removed the unused space, while still maintaining the wanted slope, connection to the context and the needed room height in the Viking Ship Hall.



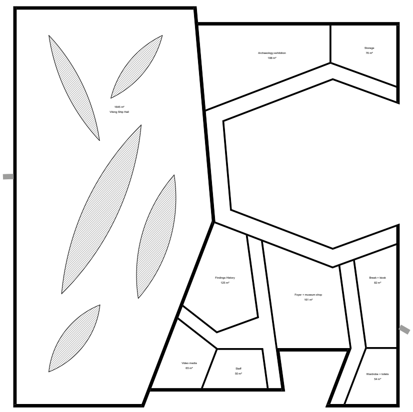
1 LARGE OPEN COURTYARD CREATING A LONG TRANSITION SPACE



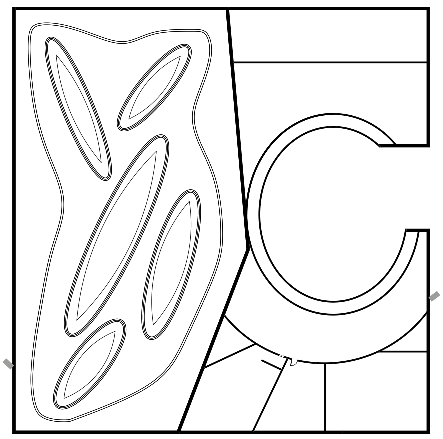
2 NARROWED COURTYARD CREATING AN UNPLEASENT STAY



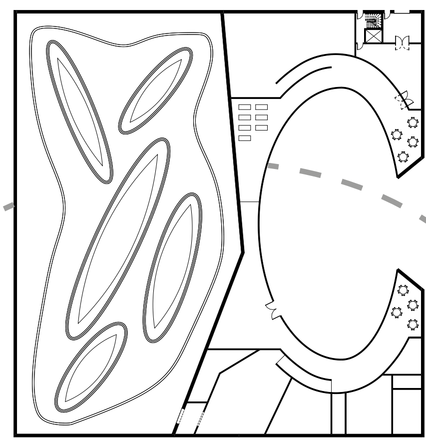
3 SQUARED COURTYARD EMBRACED BY MUSEUM FUNCTIONS



4 PENTAGON SHAPED COURTYARD CREATING A BETTER FUNCTION PLACEMENT



5 CIRCULAR COURTYARD CREATING BETTER MOVEMENT AND CONNECTIONS

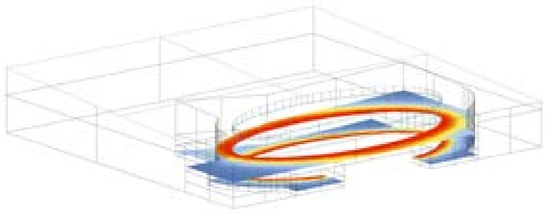


6 OVAL SHAPED COURTYARD CONNECTING ALL OF THE FUNCTIONS

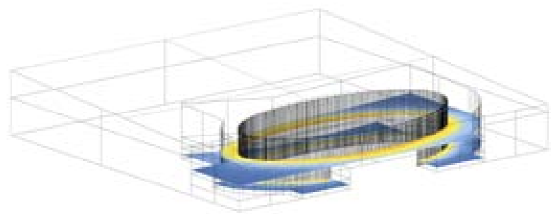
Ill. 69, investigations on function placement

DAYLIGHT

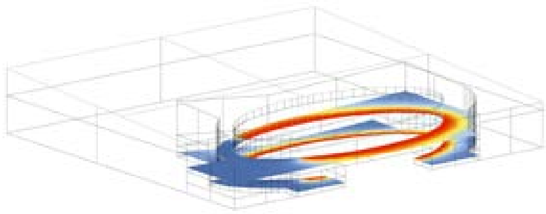
INDOOR ENVIRONMENT IN COURTYARD-ADJACENT ROOMS



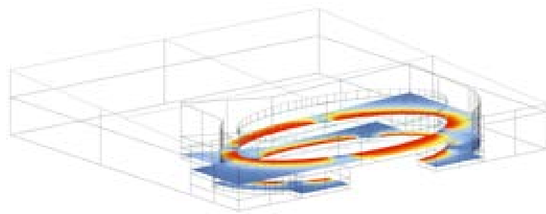
100% GLAZING



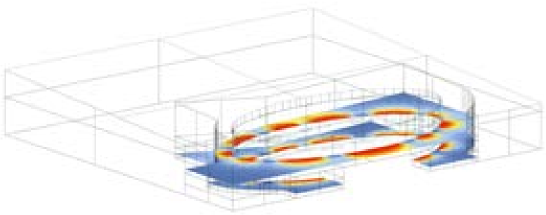
100% GLAZING WITH LAMELLA SHADING



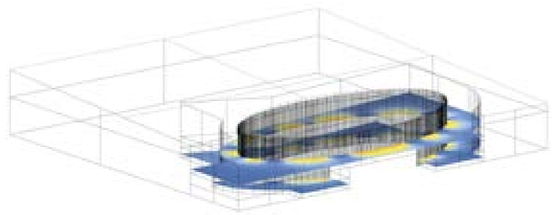
75% GLAZING CONTINUOUS



75% GLAZING SCATTERED



60% GLAZING SCATTERED



60% GLAZING SCATTERED WITH LAMELLA SHADING

DAYLIGHT FACTOR (%)

Ill. 70, daylight investigations in courtyard-adjacent rooms

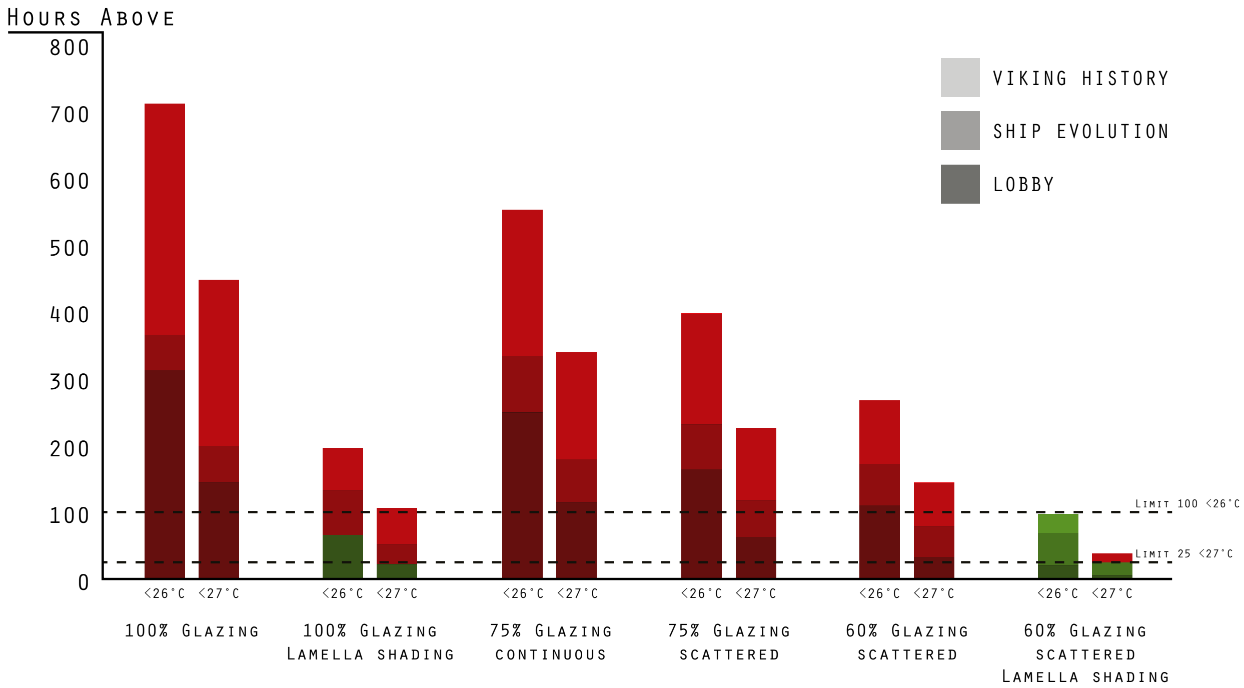
The courtyard area has been imagined to be a transparent and open façade to the indoor activities. However, as it has been intended to be 100 % transparent with a large, glazed area, it is important to investigate the influence of the indoor environment. This study looks through six design iterations measuring each one of these both on obtainable daylight and overheating risks. These results are obtained through grasshopper- and BSim simulations, whereas additional overheating results can be found in appendix 6.

The first iteration confirmed what was expected; a large amount of daylight throughout the two floors, but a critical amount of overheating in the adjacent rooms which consists of the Lobby, including both reception, workshop area, museum shop, and break room, and the first floor consisting of the exhibition spaces Viking History and Ship Evolution. These values are presented on ill. 70.

By introducing lamellas as a shading element, the overheating risks are substantially lowered without actual compromising on the daylight in the rooms. However, the first floor is still above the required limits of overheating requiring another solution.

OPERATIVE TEMPERATURES

INDOOR ENVIRONMENT IN COURTYARD-ADJACENT ROOMS



Ill. 71, operative temperatures in courtyard-adjacent rooms

As to not rely on additional mechanical ventilation to obtain a good indoor environment, the glazing area is reduced to lower the passive heating gained from the direct sunlight. Two iterations are tested with a continuous wall façade and a more scattered approach making the courtyard façade consists of 75 % glazing. These iterations shows that an evenly scattered façade varying between wall and glazing has a lower overheating risk blocking more direct sunlight than that of a continuous wall though the result will vary depending on placement of the wall.

Lowering the glazing area to 60 % shows to have little effect on the daylight but affects the operative temperature in the building effectively. As a final iteration, this iteration is combined with lamella shading resulting in an acceptable amount of daylight and reducing the amount of overheating mostly below the limit. The first-floor room Viking History shows to be affected by more overheating.

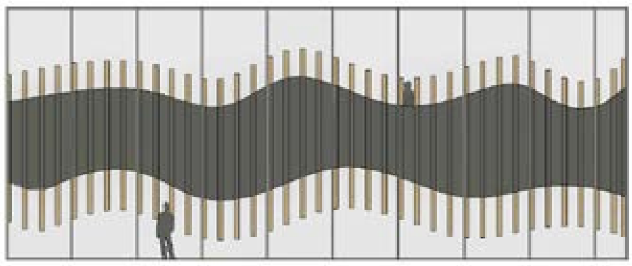
The analyses show this issue appearing around 16.00 reaching peak temperatures in this hour. To counteract the remaining hours, it will be possible to utilize natural ventilation. All these aspects will be taken into account in further design iterations.

COURTYARD FACADE

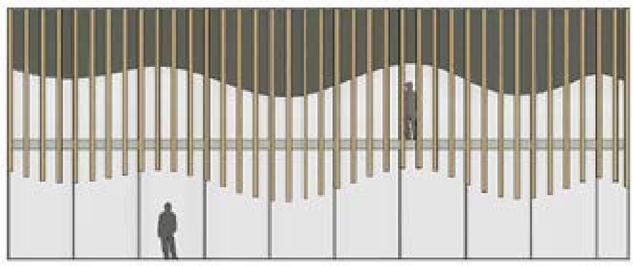
MATERIALITY & EXPRESSION

The initial vision for the courtyard facade was to create an organic shaped facade that adds to the experience of the courtyard and to achieve a sense of beauty, harmony, and a connection to the oval shape of the courtyard. Based on the previous study regarding the indoor environment and daylight in the adjacent rooms, it was clear that the glazing area needed to be minimized to 60%, while also adding lamellas as a shading element. This resulted in a study that investigated how to accommodate the 60% glazing and lamella shading, and how the expression could add to the experience of the courtyard. Therefore, utilizing curved and wavy forms was investigated, as this could be used to achieve an open, and welcoming facade in some places, while adding shade to the places needing it. The challenge for this facade was to create a balance between the desired wavy expression and the earlier mentioned daylight results that underlines the importance for external shading.

The study concluded that having the solid panel as a curved element was not desirable, but rather using the lamellas as the dominant element to help achieve the wavy look and have the solid panels be scattered equally around the facade, was a better choice. However, though this solution has some desirable qualities, the wavy lamella can seem to make the courtyard feel smaller, as well as separated from the inside facilities. It is wished to keep the ground floor facade very welcoming and open, which led to a decision of having the lamellas only on the second floor glazing area, as these are also the critical rooms. In that sense, the courtyard had become more inviting and connected to the facades as well as the rest of the volume.

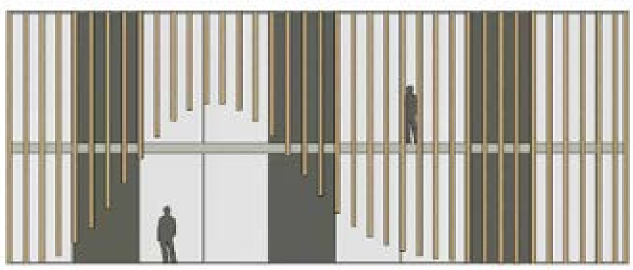


CURVED SOLID PANEL & LAMELLA IN THE MIDDLE



CURVED SOLID PANEL & LAMELLA IN THE TOP

CURVED SOLID PANEL IN TOP & LAMELLA AS OPENING

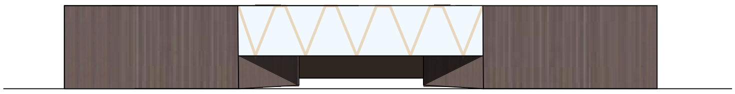


VARIED SOLID PANELS & LAMELLA AS OPENING

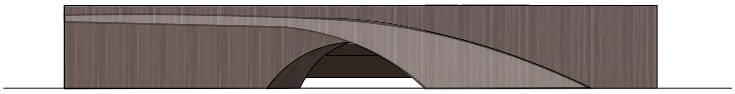
Ill. 72, courtyard facade investigations

ENTRANCE GATEWAY

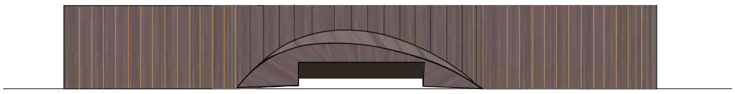
MATERIALITY & EXPRESSION



GLASS AREA

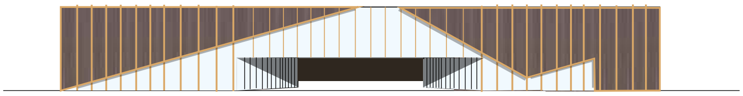


TWISTED ELEMENT

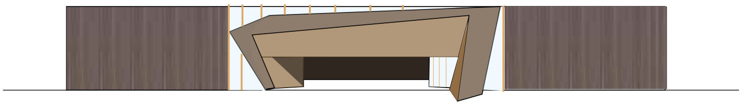


CURVED FRAMING

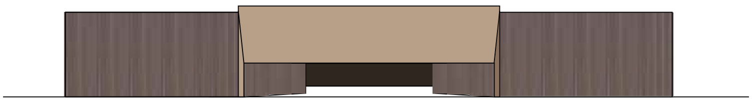
OVERHANG



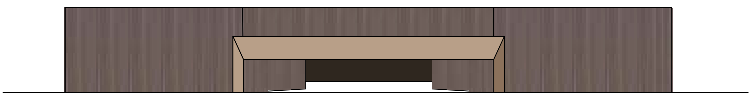
VISIBLE STRUCTURAL SYSTEM



LARGE ENHANCING



TOWERING PANEL



SUBTLE ENHANCING

Ill. 73, entrance gateway investigations

Considering that the building only has one entrypoint through the courtyard, it is important that this entry point is clear, visible and understandable. This is achieved by giving enough width and contrast for the entrance to be seen from a long distance, and by the use of contrasting colors for wood, to create a more dynamic look. Several iterations have been investigated, to see which qualities were desirable. Some of the iterations are of a wild expression, some integrate curves and some are using a larger glass area to give views into the building.

Considering that the wish is to keep the building somewhat closed off on the exterior side, to create the concept of keeping it as a "mystery box", the larger glass area is not desirable, as it will make the facades too open.

The curved form adds a quality in the sense of it standing out from the rest, and therefore making it visible. This is, however, causing too many elements, which makes the entrance gateway feel disturbing compared to the geometrical building.

The subtle enhancement of the entrance gateway functions as a clear and visible entrypoint, while still fitting into the geometrical concept, making this iteration the optimal solution to integrate in the final design.

EXTERIOR FACADES

MATERIALITY & EXPRESSION

The expression in the exterior facades should compliment the concept of being a mystery box, but should also add character to the building and make it visible in a subtle way. To connect the building to the rest of the museum facilities, and to connect it to the theme it exhibits, the facade material will be a gray toned thermowood, which is in relation to the buildings on the museum island. The following study investigates how the expression in the facade could be, and how to add character to a building with large and closed off facades.

The first iteration is to have vertical wooden boards, which is the same as many of the buildings on the island. This is, however, not giving the museum building a unique character, as it is a very classic way of using wood as facade material. Another way could be to use horizontal wooden boards, also similar to the museum island, but in a more unique manner. None of these two iterations is making the building special in any way, which is something that is desirable. Although the building should represent itself as a mystery box, it should still create an impression that makes one explore it even further. In the same matter, it would be a quality if the large facades could represent the theme it exhibits in some way; the viking age and their trademark of water.

This inspired a new iteration, where angled wooden boards were to create the feeling of a wavy expression, to symbolize the element of water, which has been a dominant factor throughout the design. This iteration was further developed into a more soft expression, and the use of a wavy curve following the entire building. This approach blends into the natural landscape and at the same time complements the nearby structures by covering it fully with wood. This approach is therefore concluded to create a more cohesive relationship between the new viking ship museum and its surroundings.

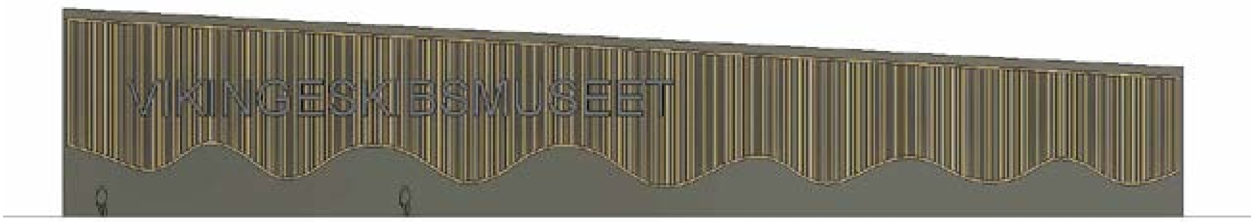
APPEARANCE OF GRAY-TONED THERMOWOOD

Ill. 74, grey-toned thermowood

VERTICAL WOOD BOARDS

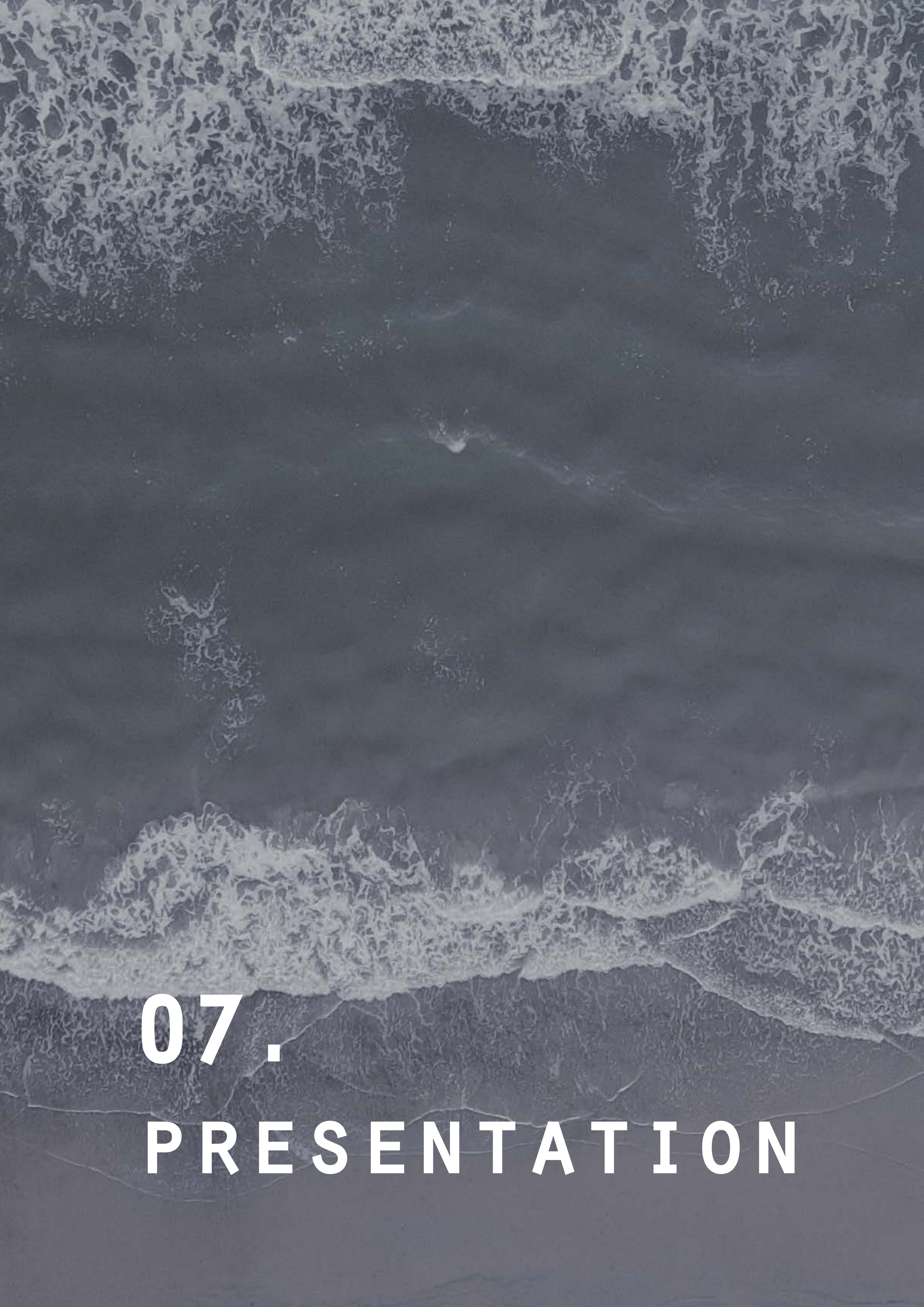
HORIZONTAL WOOD BOARDS

ANGLED WOOD BOARDS



WAVE-FORM IN THE WOODEN BOARDS

Ill. 75, exterior facade investigations

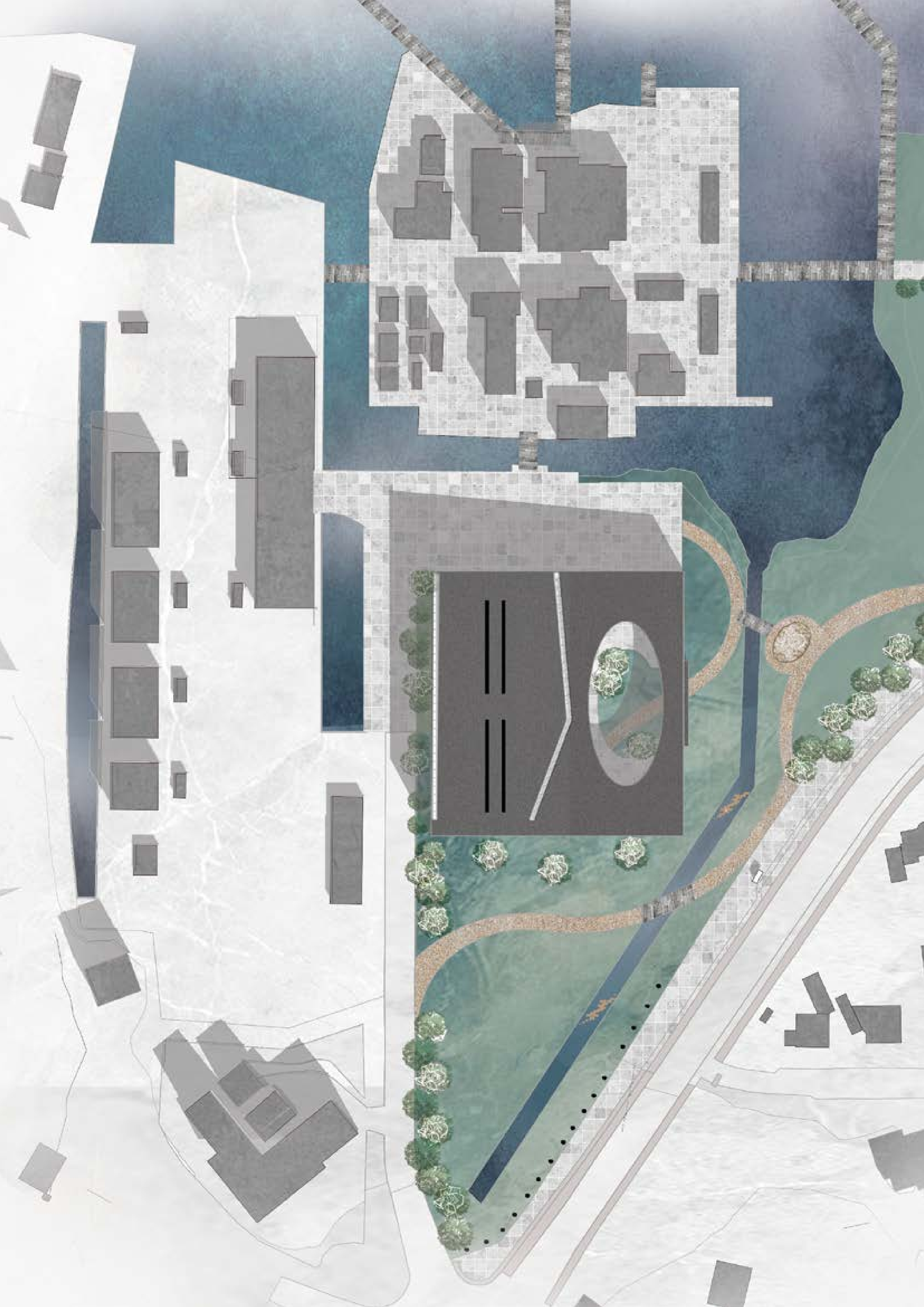


07.

PRESENTATION

Ill. 76
Photographer: Line Bundgaard Jensen

Ill. 77, arrival at focal point looking towards the entrance



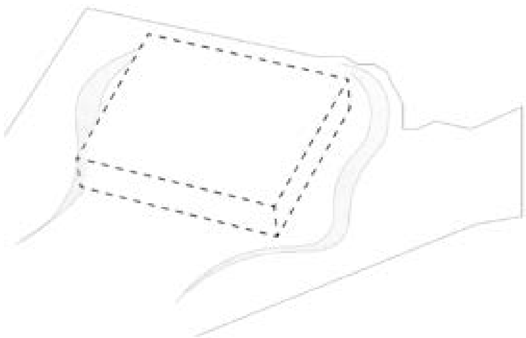
MASTERPLAN

The new museum is placed west of the site, acting as a binding element between the Museum Island and the existing Museum. The placement ensures that the new museum is able to create a safe environment for the Viking ships avoiding the rising water level to become an issue. An integrated pathway in the urban area acts as a leading guide towards the museum, where a viking-inspired focal point connects the different paths, with a direct view towards the gateway-inspired entrance point. The existing water canal running across the site has been integrated as a boundary of the museum, ensuring a connection to the remaining urban area, as people are guided along the paths. The existing museum building will be repurposed to house reconstructed ships during winter establishing a ship storage and slipway east for the building allowing for easy access for the ships. Moreover, a playground has been integrated in the urban area, to create an active and playful place, adding atmosphere and life to the area.

1:1100

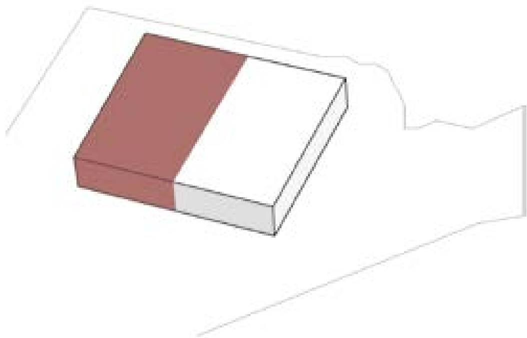
Ill. 78, masterplan

CONCEPT



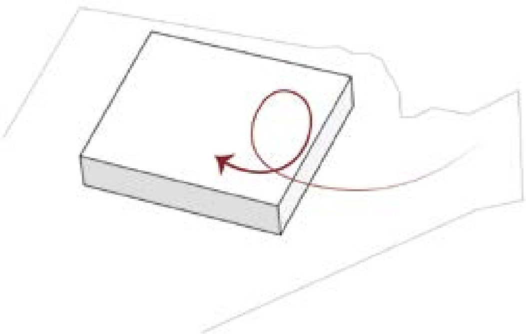
VOLUME & TERRAIN

A geometrical volume compliments the surroundings and protects the ships by being placed at level 2,53 m



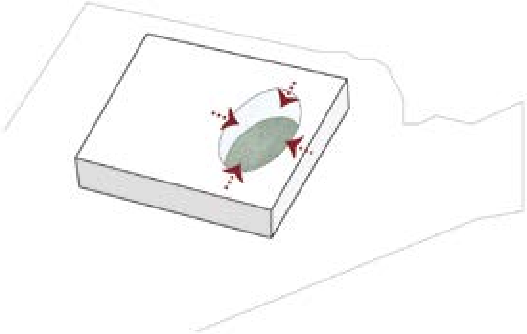
DIVIDING FUNCTIONS

Dividing the functions creates a clear indication of the inside zoning as well as balancing the height difference



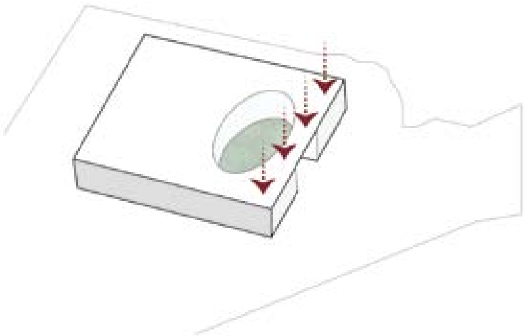
INTEGRATING URBAN SURROUNDINGS

Integrating the urban surrounding connects the building to the activities and movements along the site



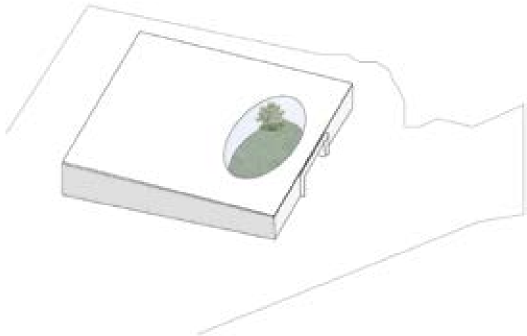
VIEWS TOWARDS COURTYARD

Views towards the courtyard allows for daylight and a connecting experience between inside and outside



CREATING ONE-SIDED SLOPE

A one-sided slope connects with the surrounding context while creating the needed room height for the ships

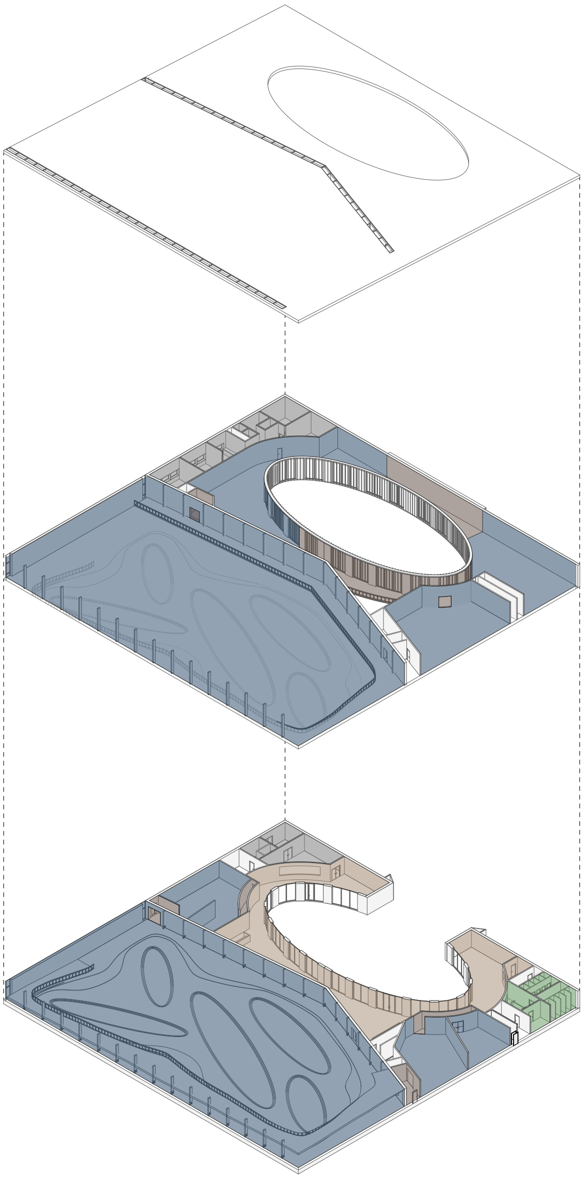


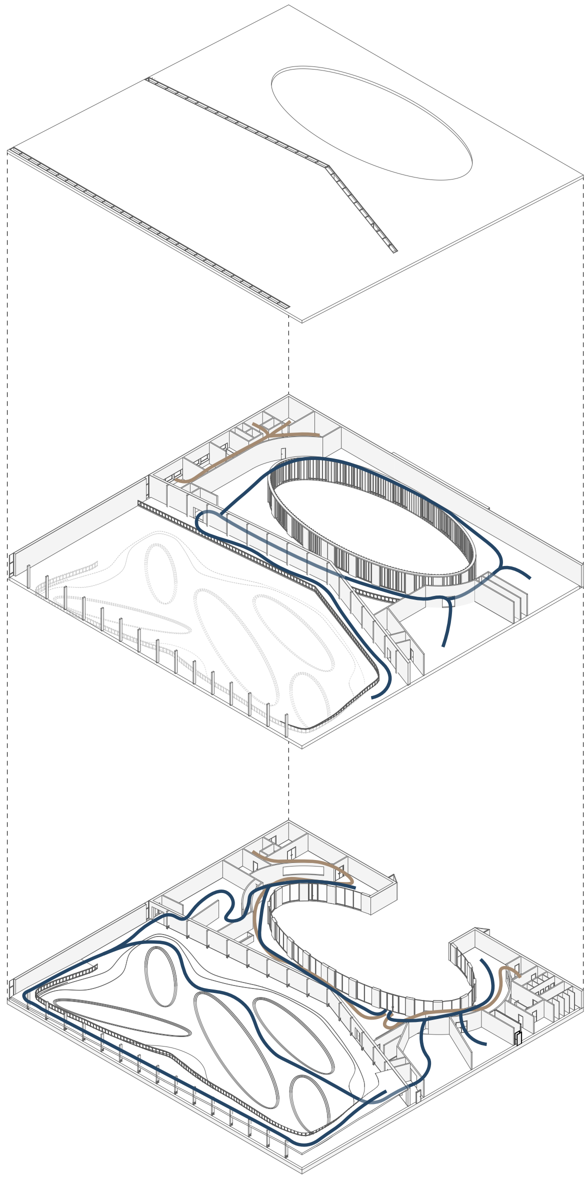
WELCOMING AREA

A visibly framed entrance gateway marks the clear entrypoint leading to a welcoming green space

Ill. 79, concept illustrations

MUSEUM FUNCTIONALITY





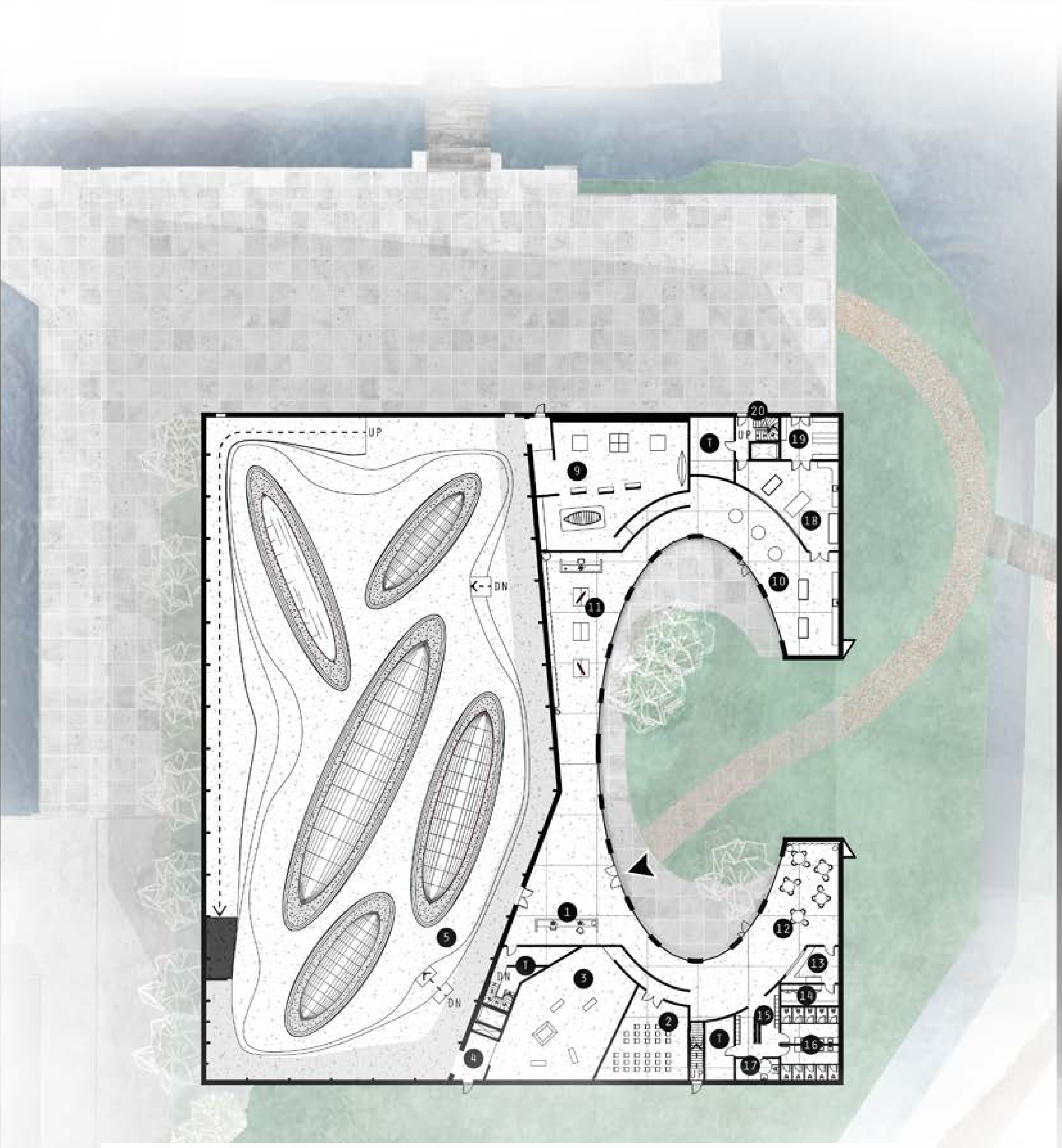
DEPARTMENTS

- EXHIBITIONS
- ARCHAEOLOGICAL RESEARCH
- ENTRANCE
- TRANSITION SPACES
- SERVICES

CIRCULATION

- MUSEUM VISITOR
- STAFF/ARCHAEOLOGISTS

Ill. 80, museum functionality



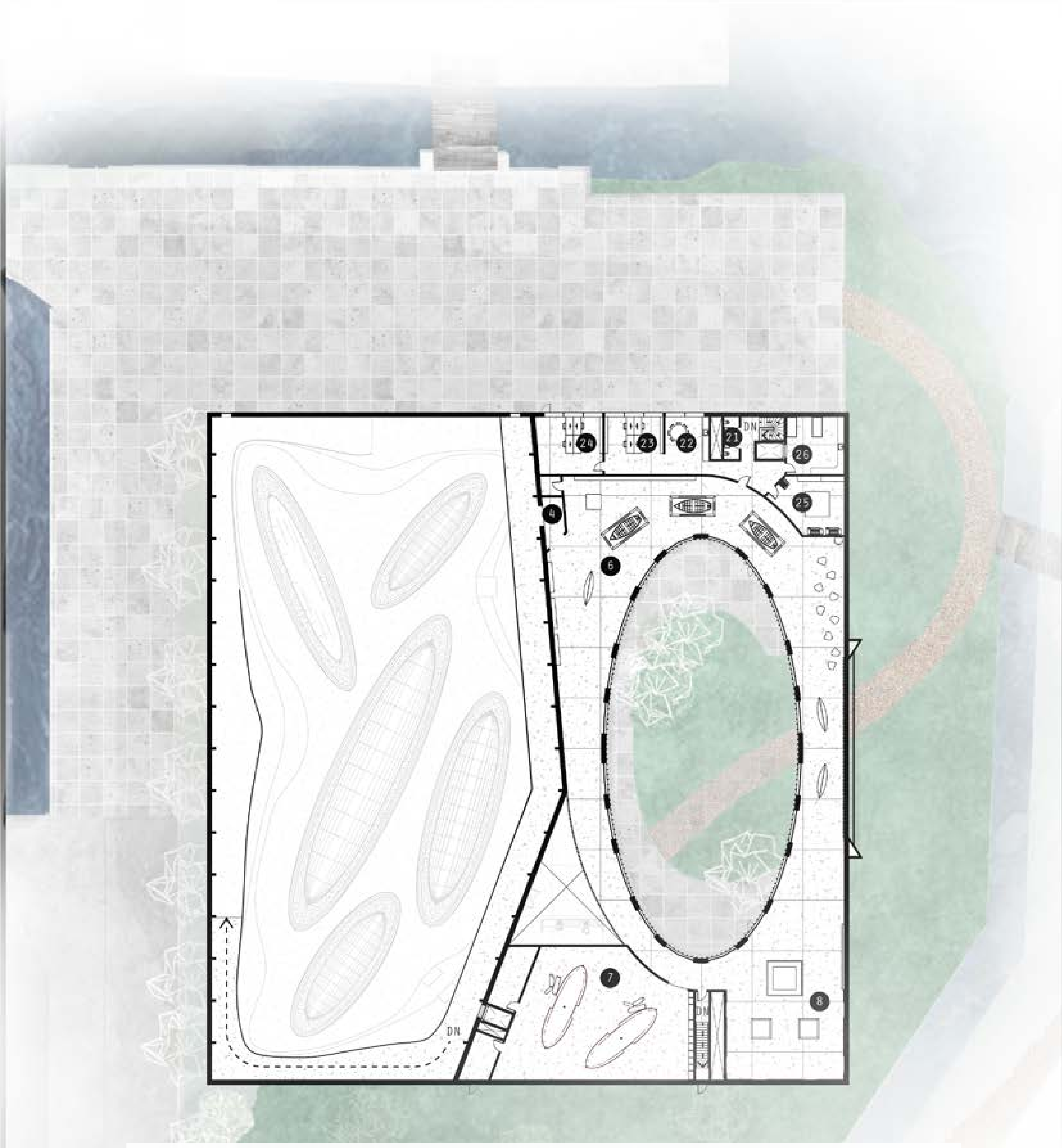
GROUND FLOOR

1. *Foyer & Reception*
2. *Video Media*
3. *History of the Findings*
4. *Transition Space*
5. *The Viking Ship Hall*
9. *Archaeological Exhibition*
10. *Open Workshop Area*
11. *Museum Shop*
12. *Break Room*
13. *Kiosk*
14. *Kiosk Storage*
15. *Wardrobe*
16. *Restrooms*
17. *H. Restroom*
18. *Visible Workspace*
19. *Archaeological Storage*
20. *Office Entry*

T *Technical Room*

1:500

Ill. 81, plandrawing ground floor



SECOND FLOOR

- 4 *Transition Space*
- 6 *Ship Evolution*
- 7 *Climb Aboard*
- 8 *Viking History*
- 21 *Office Restrooms*
- 22 *Office Break Room*
- 23 *Flexible Office*
- 24 *Permanent Office*
- 25 *Drawings Office*
- 26 *Private Workspace*

1:500

Ill. 82, plandrawing second floor

Ill. 83, visualization of the viking history exhibtion

THE BEGINNING OF THE MUSEUM STARTS AT THE FOYER

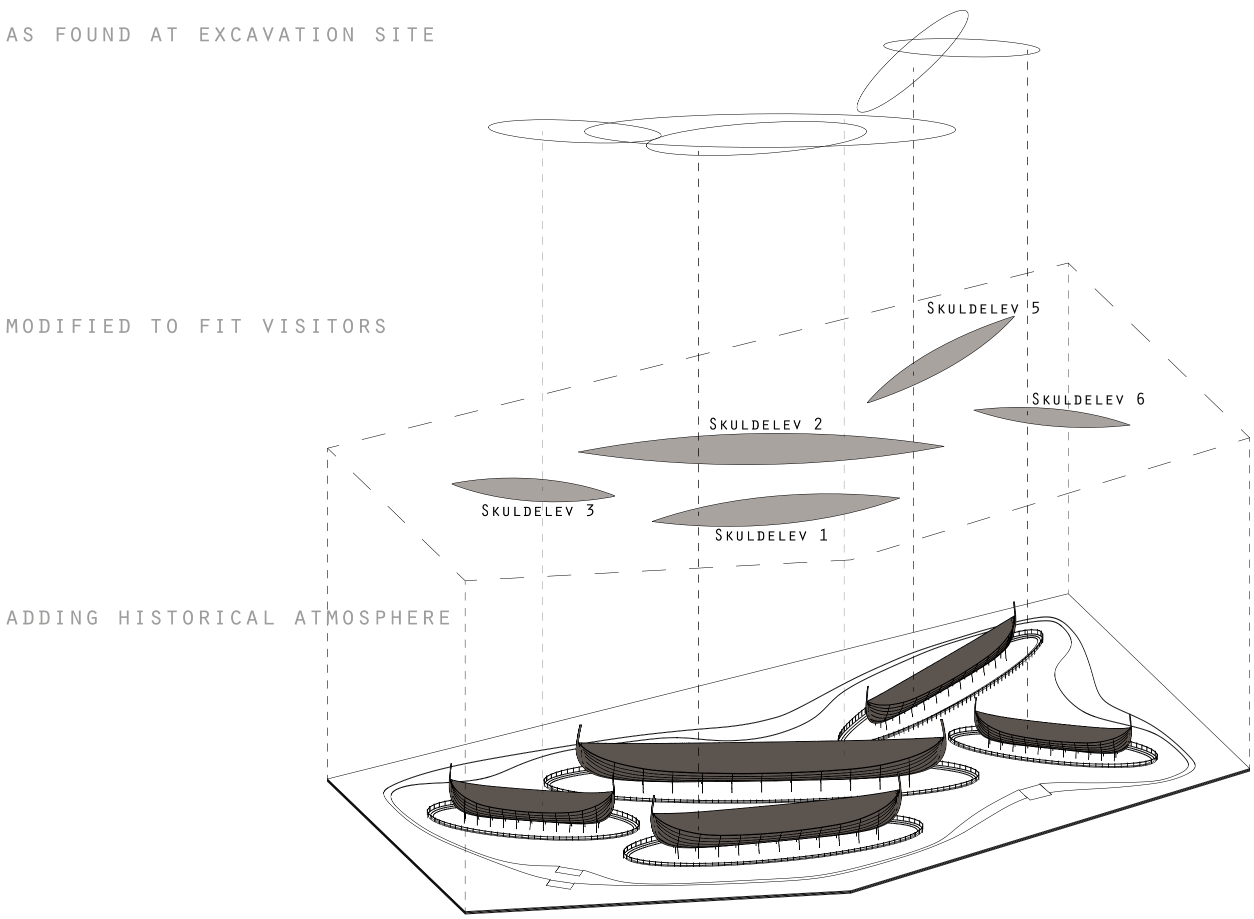
Ill. 84, visualization of the foyer

SHIP PLACEMENT

A CONCEPTUAL PRINCIPLE

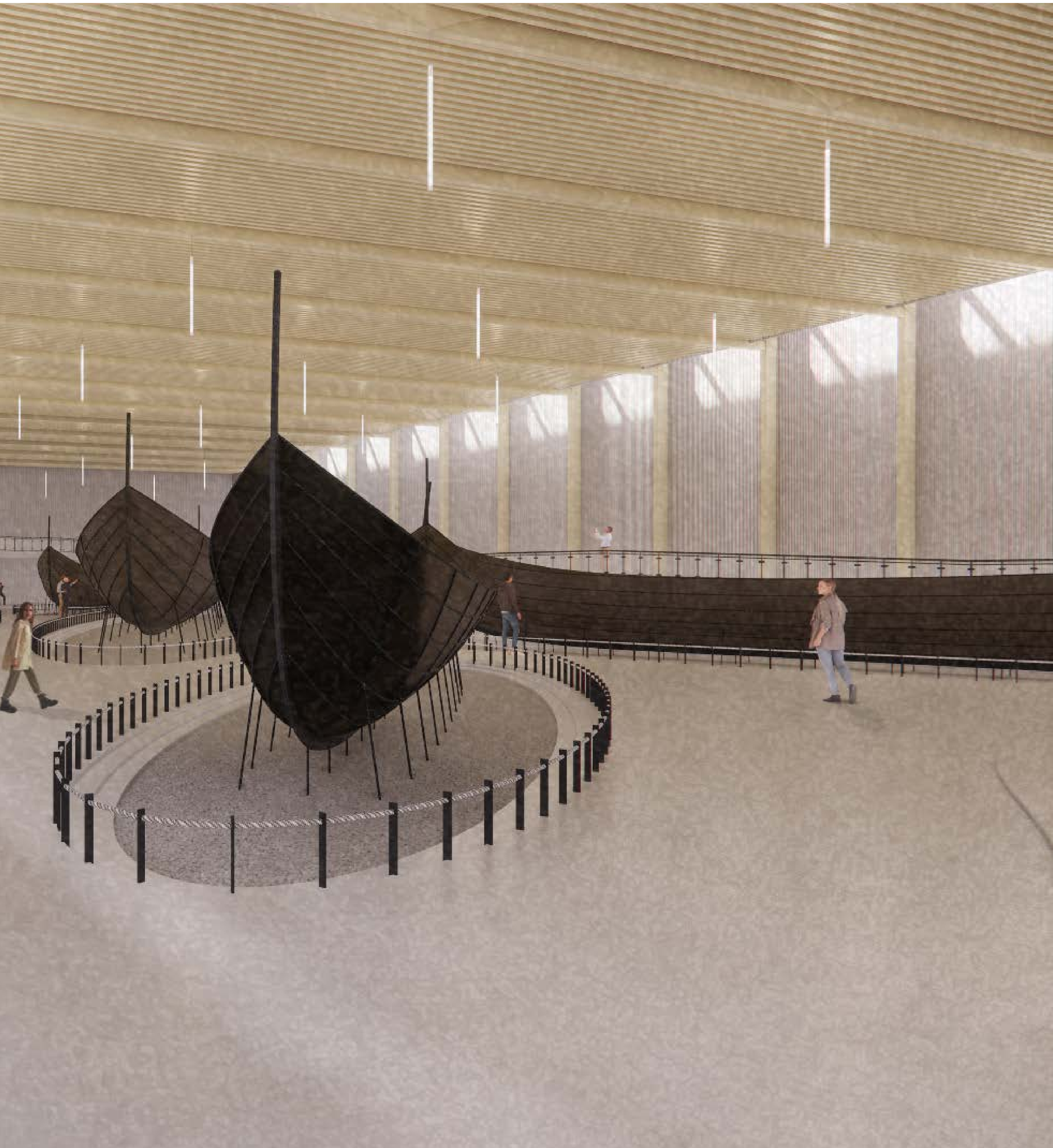
The placement of the ships have an important impact, as they are the key focus point in creating a suitable atmosphere that achieves the wanted experience. The historical tale of the five Skuldelev Ships starts from the very beginning of the excavation of them, and the placement of how they were found in the water. The unique placement inspired a concept of bringing the ships back to how they were found, to enhance the unique history of them. Presenting a large artifact such as a ship encourages to create a complimenting atmosphere to present them in.

In the new Viking Ship Museum, they are placed as they were found at the excavation site, modified to fit visitors walking among them without damaging them, and with an atmospheric presentational element in the curved floor. The stepping down towards the ships, as well as the larger curve embracing the ships, adds an effect of a waters edge, which ultimately creates an atmosphere where the ships are, once again, back at the beginning; situated in the water in the placement where the history began.

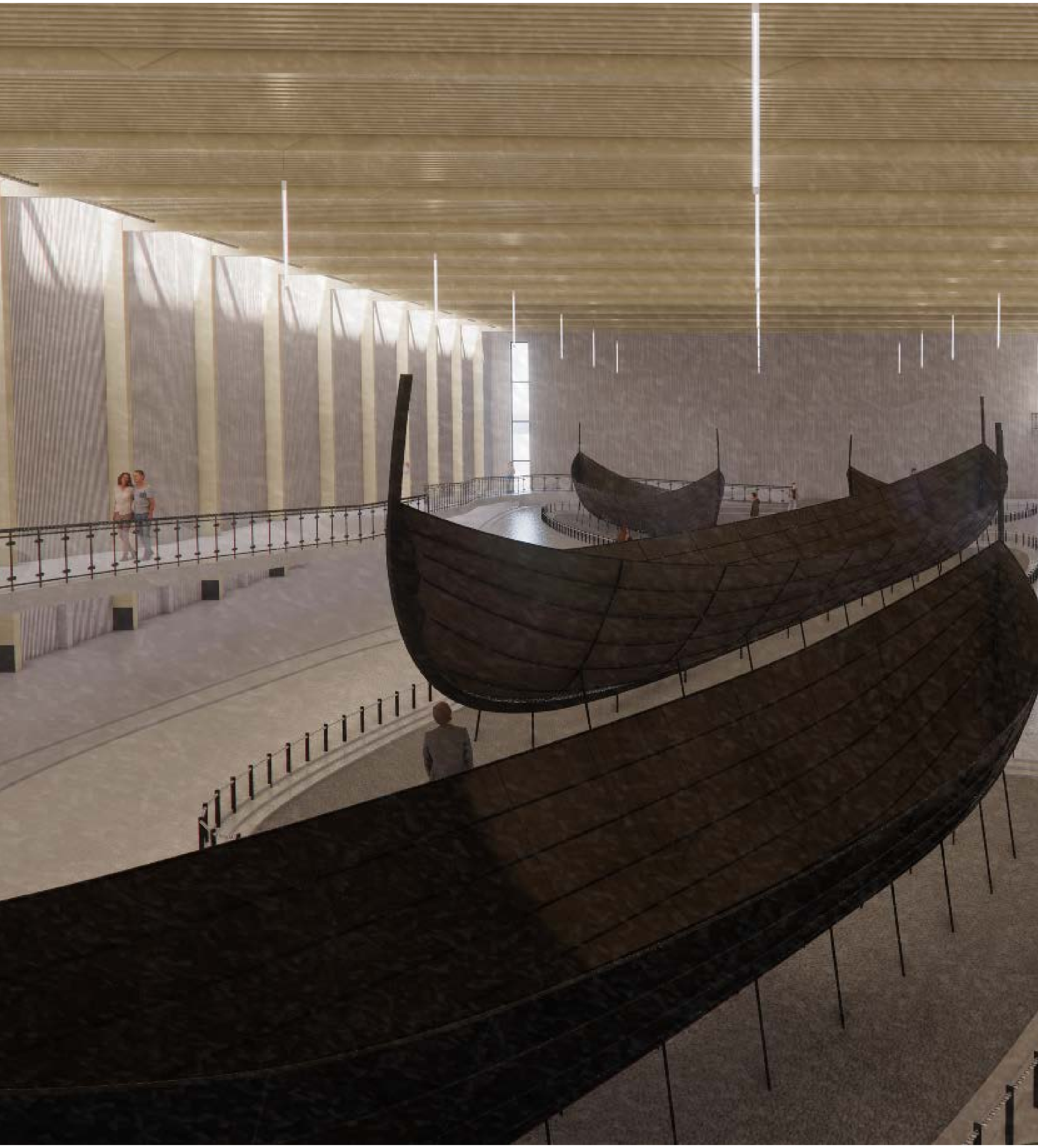


Ill.85, ship placement

THE VIKING SHIP HALL

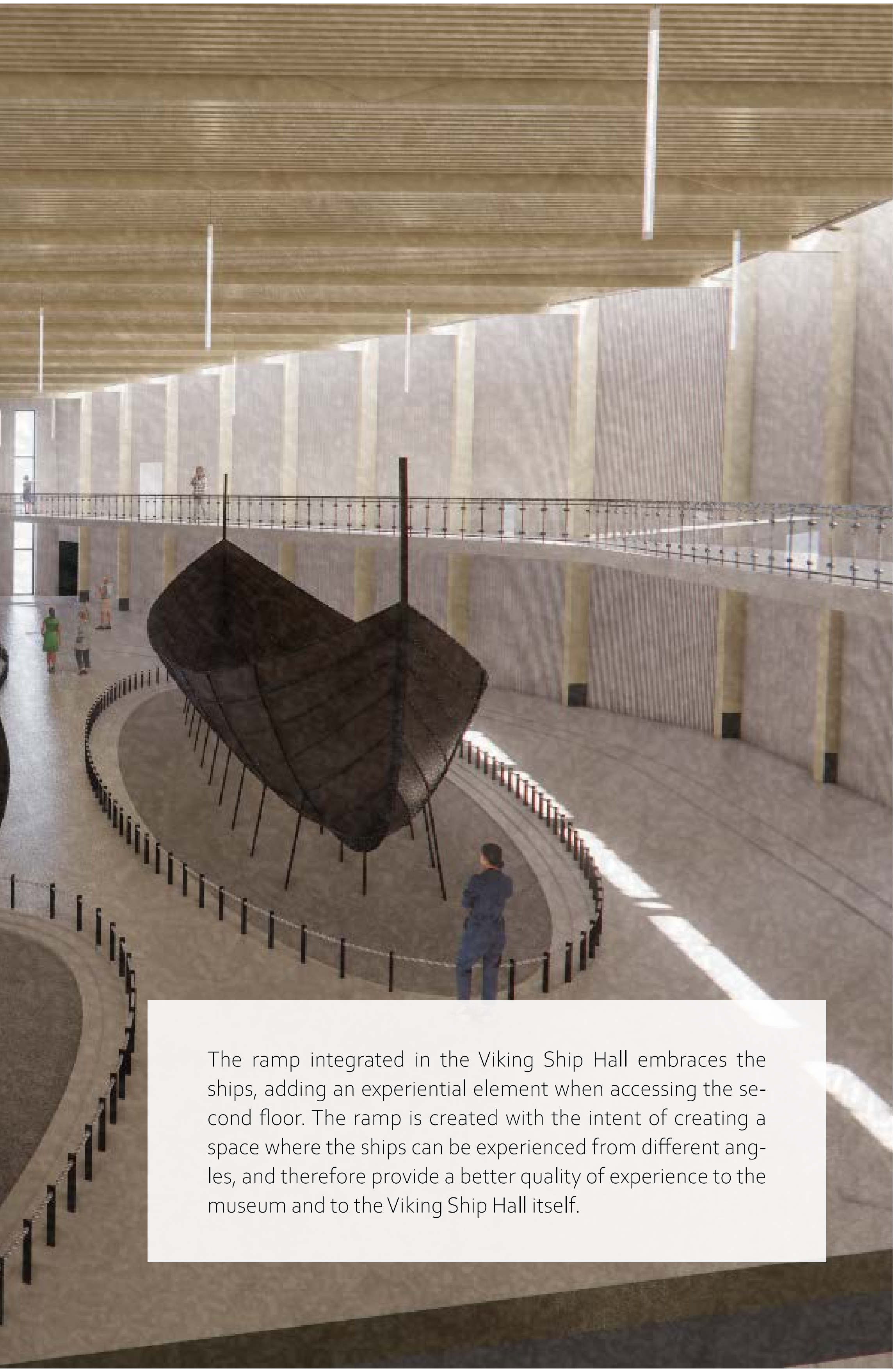


Ill. 86, visualization of the viking ship hall



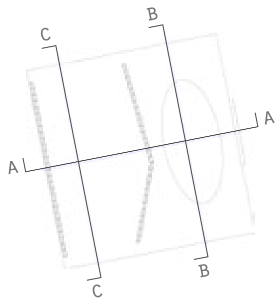
Ill. 87, visualization of the viking ship hall standing on the ramp

RAMP EXPERIENCE



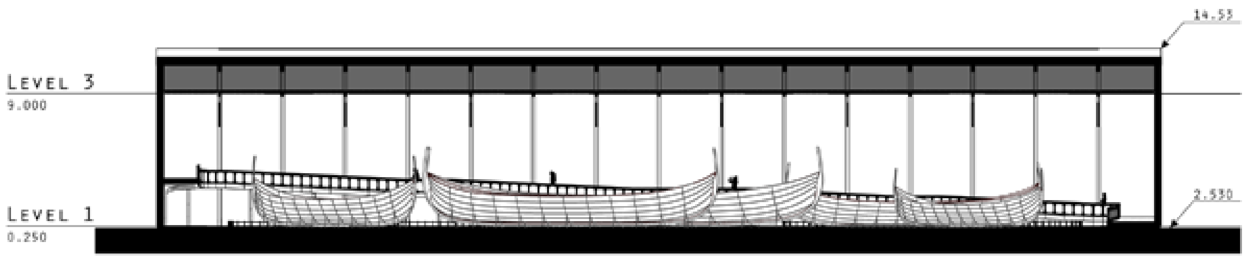
The ramp integrated in the Viking Ship Hall embraces the ships, adding an experiential element when accessing the second floor. The ramp is created with the intent of creating a space where the ships can be experienced from different angles, and therefore provide a better quality of experience to the museum and to the Viking Ship Hall itself.

SECTIONS



SECTION AA 1:500

SECTION BB 1:500



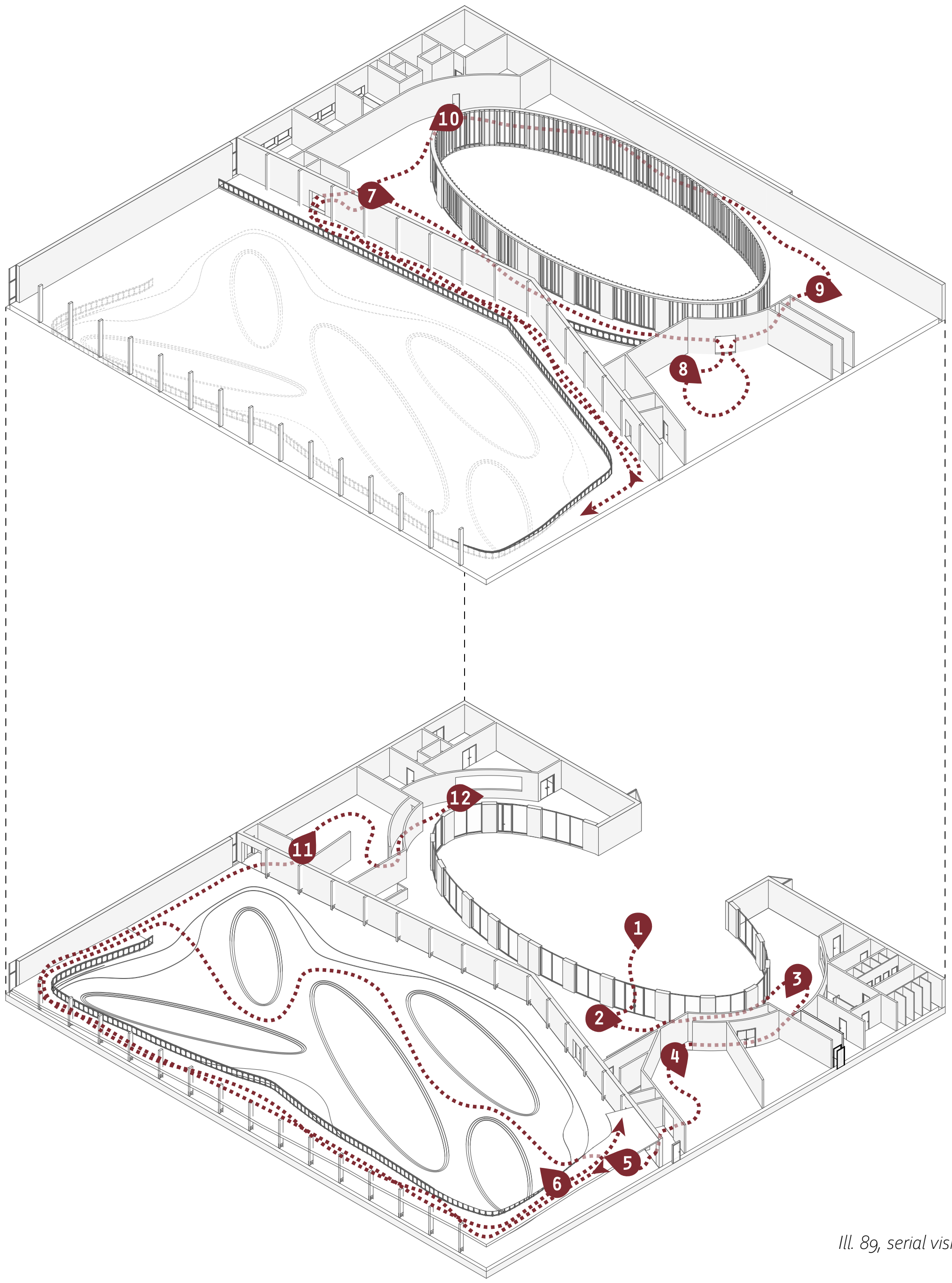
SECTION CC 1:500

Ill. 88, sections 1:500

EXPERIENCING THE MUSEUM

A SERIAL VISION

A serial vision throughout the museum illustrates the experience of entering and visiting the museum. The different exhibitions have been made to illustrate different atmospheres, each of them corresponding to the exhibition at display. Entering at the foyer, one moves along the curved courtyard, entering the History of the Findings first, to inform of the ships before experiencing them. The Viking Ship Hall allows for multiple experiences along with the ramp acting as a binding element to the second floor. The exhibition tour ends at the archaeological exhibition where the visitors can move further to the open workshop area, and experience archaeological work on their own.



Ill. 89, serial vision viewpoints

1. COURTYARD VIEW AT ENTRANCE

2. FOYER & RECEPTION

3. BEGINNING OF TOUR

4. HISTORY OF THE FINDINGS

5. ENTERING THE SHIP HALL

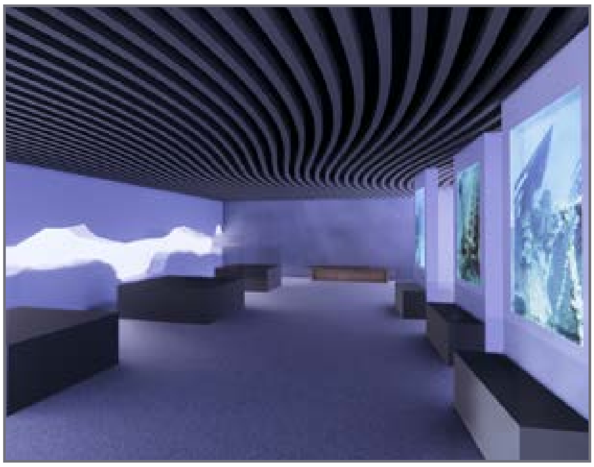
6. STANDING ON THE RAMP

7. ENTERING THE SECOND FLOOR

8. CLIMB ABOARD

9. VIKING HISTORY

10. SHIP EVOLUTION

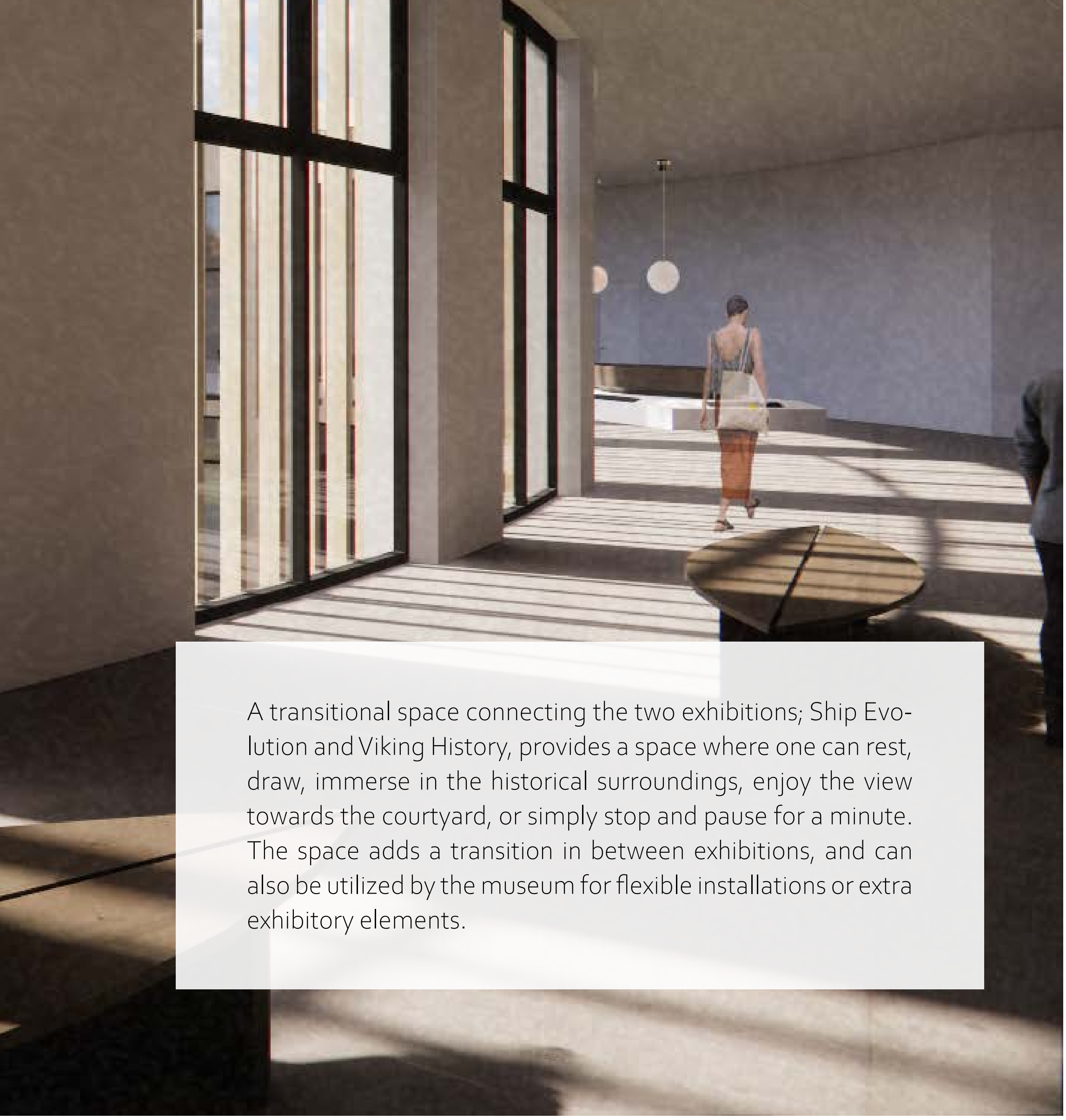


11. ARCHAELOGICAL EXPERIENCE

12. OPEN WORKSHOP AREA

Ill. 90, visualizations of serial vision views

Ill. 91, visualization of the transition space



TRANSITIONAL SPACE

A transitional space connecting the two exhibitions; Ship Evolution and Viking History, provides a space where one can rest, draw, immerse in the historical surroundings, enjoy the view towards the courtyard, or simply stop and pause for a minute. The space adds a transition in between exhibitions, and can also be utilized by the museum for flexible installations or extra exhibitory elements.

Ill. 92, visualization of the history of the findings exhibition

DISCOVERING THE HISTORY OF THE FINDINGS

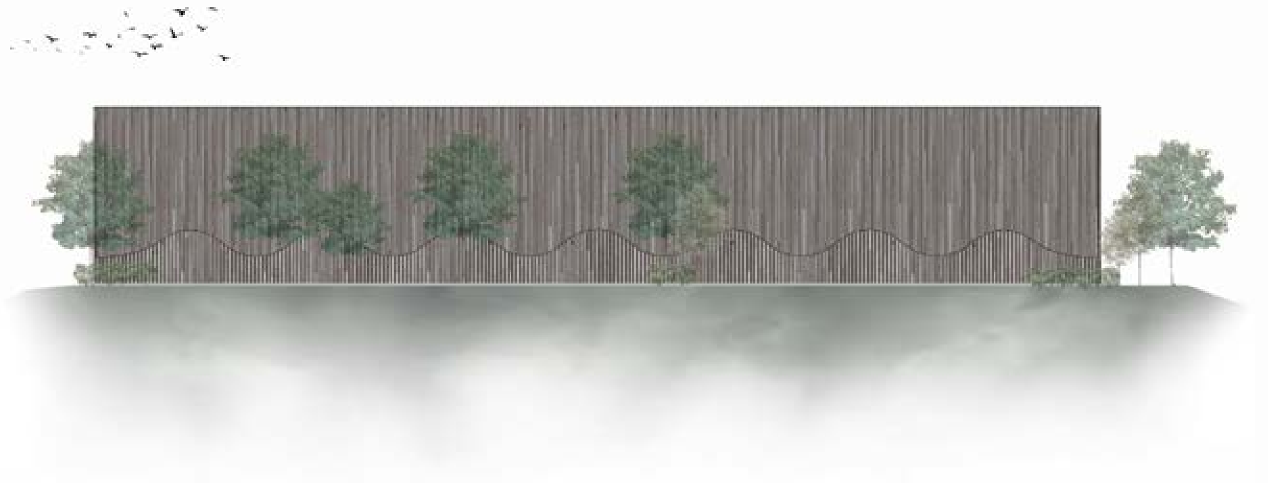
The History of the Findings exhibition displays an atmosphere reminiscing to the excavation site of which the ships were found. Implementing wooden boards on the walls enhances the experience of actually standing in the excavation site, immersing in the history of how the ships were used, found, excavated, processed and displayed in the original museum.

The archaeological exhibition displays the findings that the archaeology department of the museum discovers. The materiality is turned blue and implements elements to showcase an experience of being under water, and feeling as a part of the environment in which the findings were excavated, to create an atmospheric experience in relation to the exhibition.

Ill. 93, visualization of the archaeological exhibition

ELEVATIONS

EAST FACADE 1:500



WEST FACADE 1:500

NORTH FACADE 1:500

SOUTH FACADE 1:500

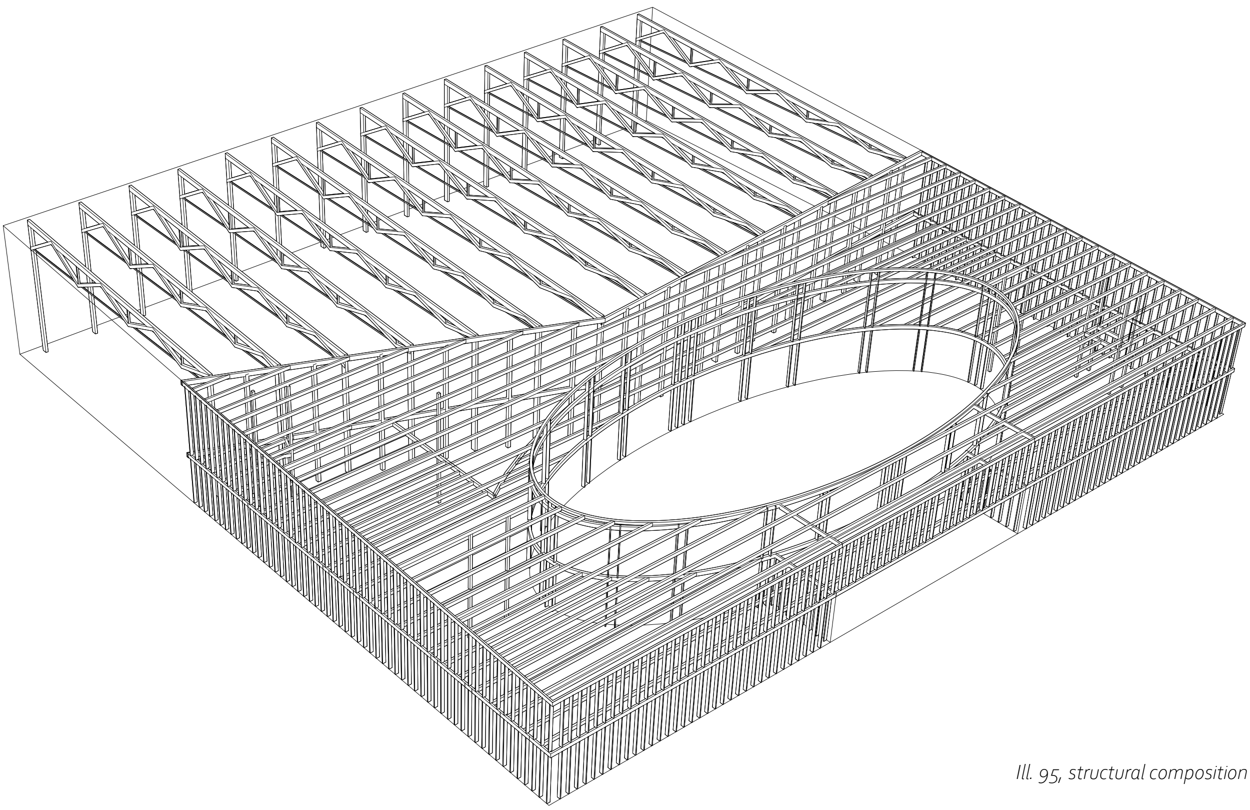
Ill. 94, elevations 1:500

STRUCTURAL COMPOSITION

The Viking Ship Museum is based on two separate structural principles each allowing for a clear communication of the divided functions. The Viking Ship Hall consists of a column and truss beam system allowing for a large open space to showcase the findings.

The other part of the building consists of a more traditional column and beam system with load-bearing columns being placed in strategic spaces in order to allow for a minimal usage of structural materials in the interior spaces to make room for all exhibitions. The structural material has been chosen to be CLT-wood of which structural calculations are based,

The drawings illustrate an initial principle of the two structural systems where the column and truss beam system has been dimensioned.



Ill. 95, structural composition

MATERIALITY

LIFE CYCLE ASSESSMENT

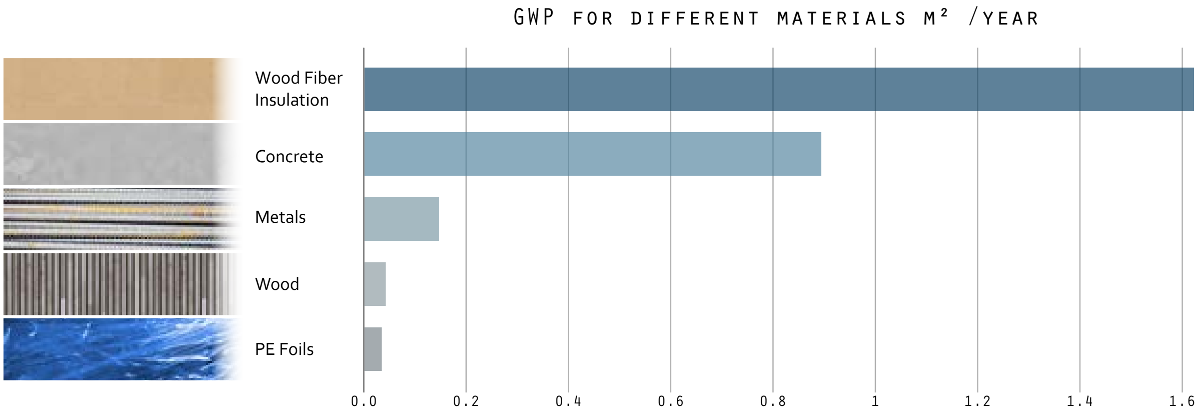
As another sustainable approach, the project has carefully chosen the used materials in order to obtain a low environmental foot-print. The Life Cycle Assessment of the building is dominated by timber materials as insulation, structure and cladding resulting in a design focusing on sustainable materials without compromising on the aesthetics.

The thermowood cladding on the exterior gives the building a unique and dark shade of appearance as the wood develops silver-gray tones when exposed to sunlight enhancing the connection between the new museum and the existing museum island.

The load-bearing system has been designed in CLT-timber throughout the building serving as a contrast to the brutalist expression of the existing museum. With wooden lamella integrated throughout the design for both walls and ceilings a touch of warmth, familiarity and elegance is added to the simple surfaces of the interior.

Due to the usage of the building and strict requirements to indoor climates, it has been necessary to utilize concrete as flooring material to sustain constant usage while also adding to the framework of each exhibition space through surface color and texture. The practical choice for a low maintenance surface while adding to the overall expression of each exhibition.

According to the Building Regulations, the limit of Global Warming Potential (GWP) for the building is 12,0 CO_2 eq./m2 per year (Social- og Boligstyrelsen, n.d.) whereas this design proposal reaches rough values of 2,7 CO_2 eq./m2 per year.



Ill. 96, LCA results

Ill. 97, visualization of the workshop area

EXPERIENCING HANDS-ON EXPERIEMENTS WITH THE ARCHAELOGISTS

The open workshop area provides space for experiences with archaeological work, where visitors can engage in the process of working with archaeological finds through the visible workspace, as well as experiment on their own.

IMPLEMENTED STRATEGIES

PASSIVE & ACTIVE STRATEGIES

ACTIVE PV-PANELS

The 500m² incorporated pv panels on the sloped roof helps generate the electricity and thereby results in having 35,2 kWh / year for the total energy consumption (appendix 7).

ACTIVE HVAC SYSTEMS

Active HVAC systems chosen for the museum regulate indoor temperature, humidity, and air quality to ensure the preservation.

ACTIVE LIGHTING SYSTEMS

To ensure that the different utlized lighting for exhibtions provides the desired lighting levels for different atmospheres within the museum, occupancy sensors has been chosen for the light systems.

PASSIVE NATRUAL TREE SHADING

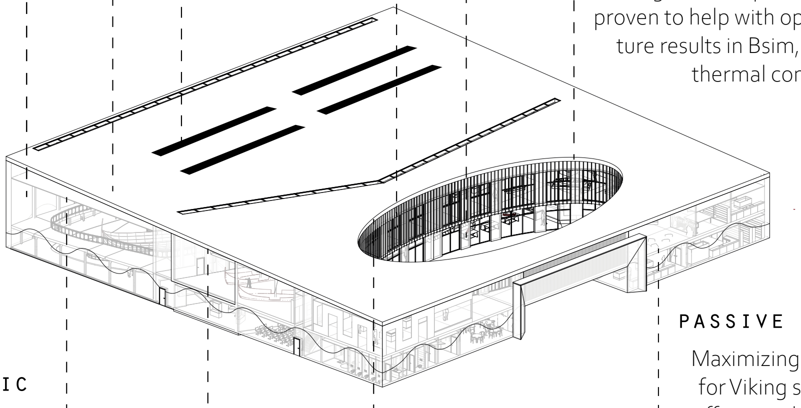
Landscaping the museum with trees provides shading, reduce heat island effects, and improve outdoor comfort .

PASSIVE NATURAL VENTILATION

The designed operable windows for the museum reduces the need for mechanical ventilation.

PASSIVE SHADING LAMELLA

The implemented lamella on the south facade minimize solar heat gain and reducing the demand for cooling during summer periods. The lamella proven to help with operative temprature results in Bsim, to ensure the thermal comfort.



PASSIVE DAYLIGHTING

Maximizing natural daylight for Viking ship hall and the offices to the north reduces the need for artificial lighting. Which doesn't only reduce the Be18 results but ensures the well-being and productivity of occupants.

PASSIVE ACOUSTIC SOLUTIONS

The viking ship halls' shape, layout amd ceiling design ensures the diffusen of sound rays,. In meanwhile the absorbation surfaces on walls reduces sound propagation. This resultes in having 1,3 s for the reverbation time.

PASSIVE SOLAR GAIN

large courtyard glazing areas captures solar heat to reduce the need for artificial lighting well as reducing to the overall energy consumption of a building.

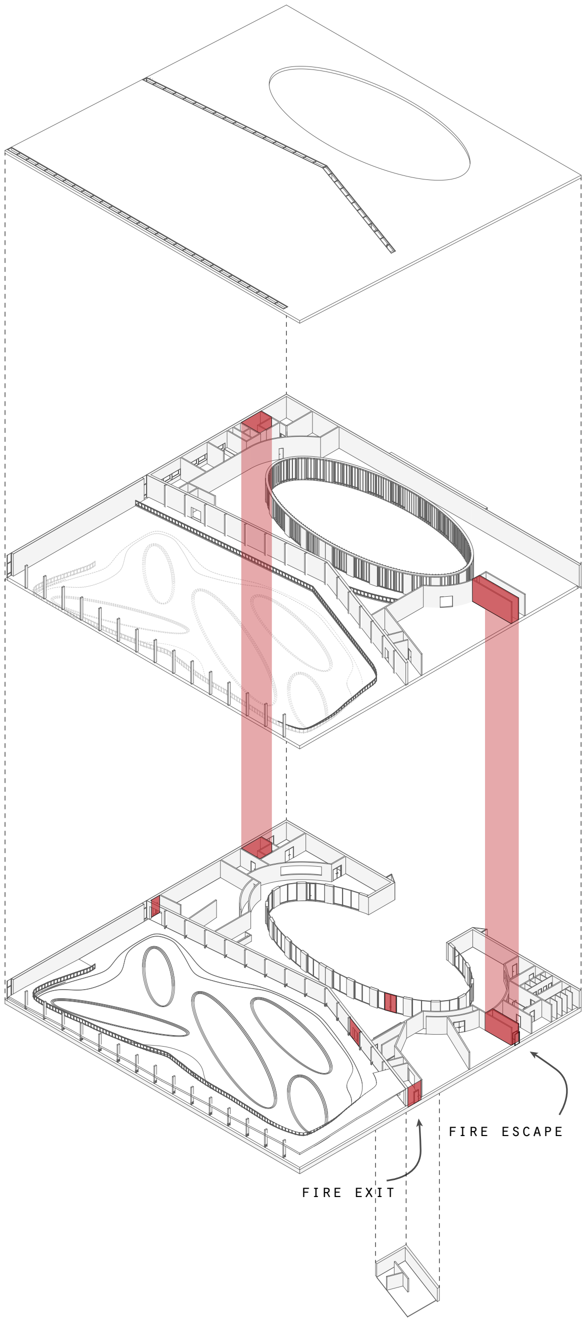
PASSIVE EFFICIENT BUILDING ENVELOPE

The museums' airtightness envelopes with proper insulation and high-quality construction materials significantly reduces energy losses and reduces the energy consumption (appendix 8).

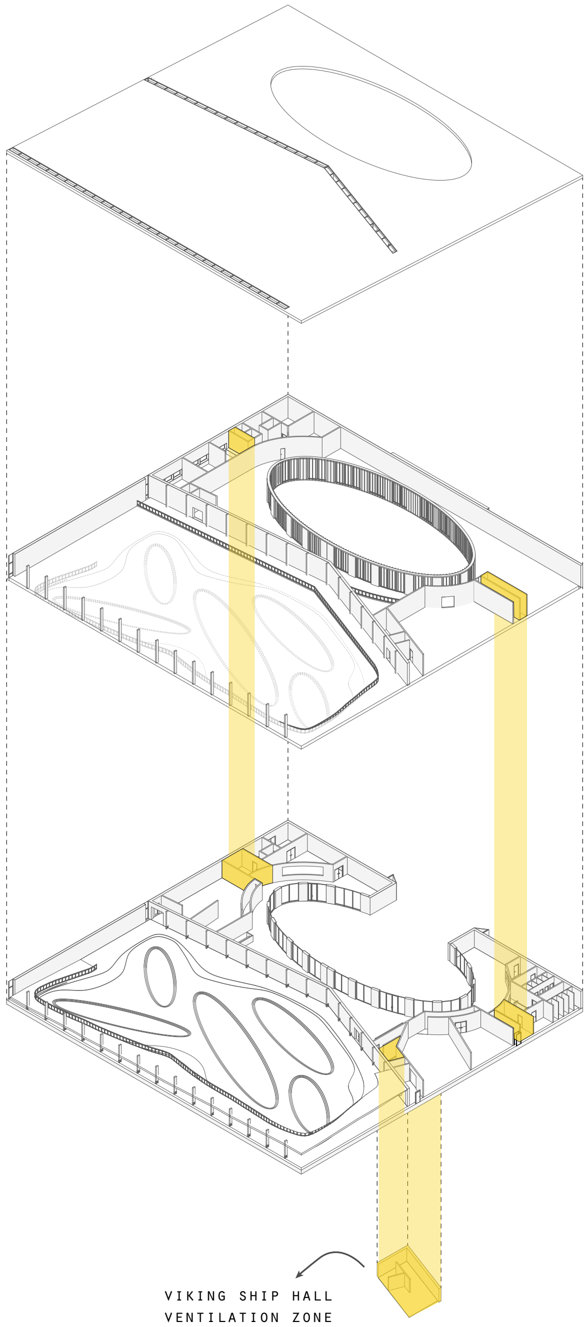
Ill. 98, implemented passive & active strategies

TECHNICAL PRINCIPLES

CONCEPTUALIZED STRATEGIES



FIRE EXITS

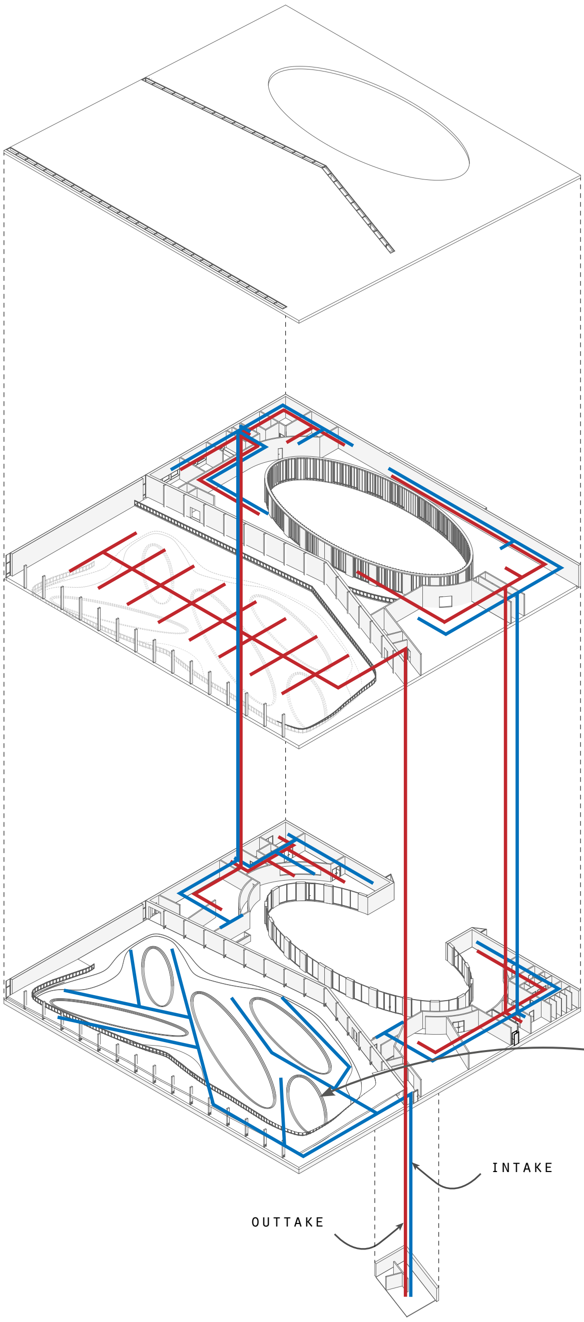


TECHNICAL CORES

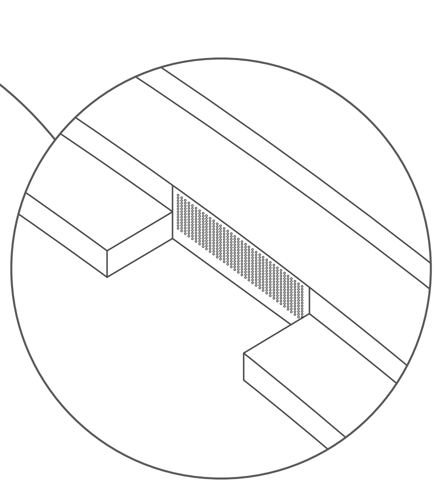
Ill. 99, technical principles of fire exits & technical cores

The mechanical ventilation system consists of three decentralized aggregates, two on the ground floor controlling respectively the southern and northern part of the museum, while a larger technical room is situated below ground, controlling the zone of the Viking Ship Hall. The technical rooms have access to intake/outtake respectively directly from the facade and from earth tubes on ground. This Viking Ship Hall-zone consists of Displacement Ventilation due to the high room height, while the rest of the building is Mixing Ventilation, hidden in the suspended ceiling in most of the rooms. To ensure that the ventilation channels fit into the suspended ceiling and the shafts from the second floor, two dimensionings of the channel system have been made (appendix 9).

In the Viking Ship Hall, the ventilation channels for outtake lies in the suspended ceiling, while intake runs below the floor, supplying the room along the curves near the ships, as these are the reasoning for the strict requirements. To make sure the armature doesn't disturb the room, these are hidden in the steps that embrace the ships, as the conceptual drawing below illustrates.



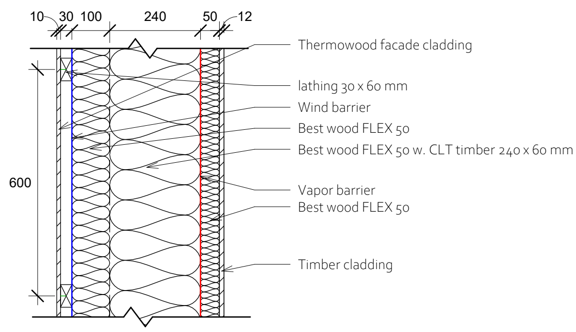
MECHANICAL VENTILATION



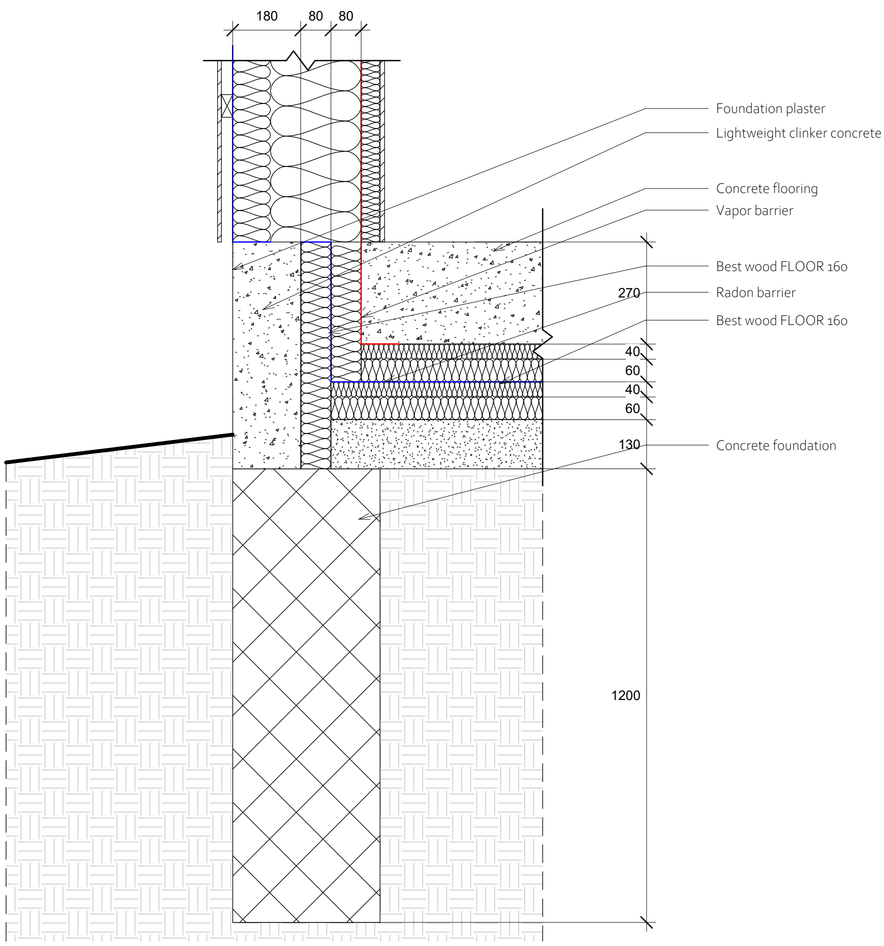
Ill. 100, technical principle of channel system

Ill. 101, technical principle of air supplying method

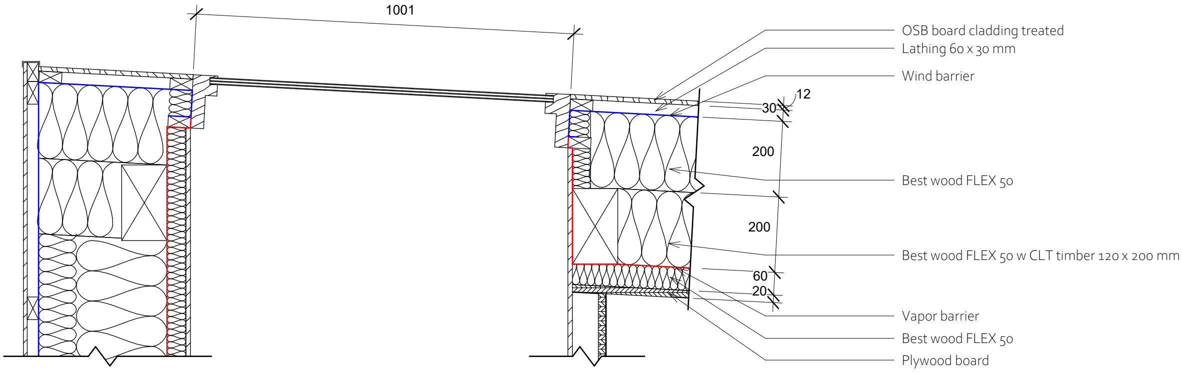
CONCEPTUAL DETAILS



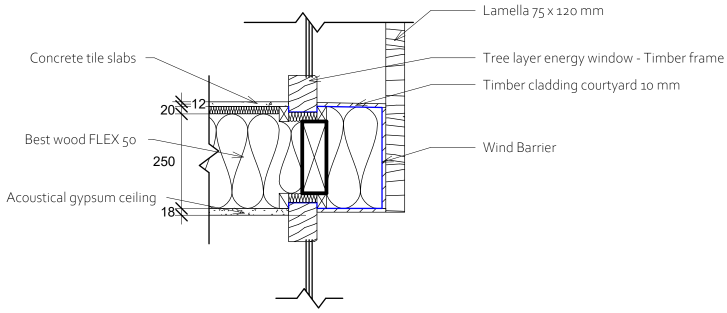
WALL DETAIL 1:20



WALL-TERRAIN DETAIL 1:20



ROOF-END & WINDOW DETAIL 1:20

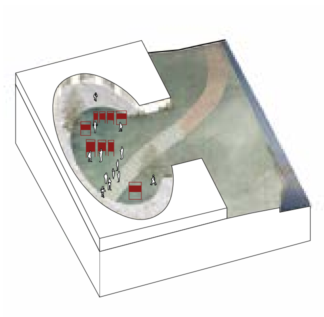


COURTYARD WINDOW & FLOOR DETAIL 1:20

Ill. 102, details 1:20

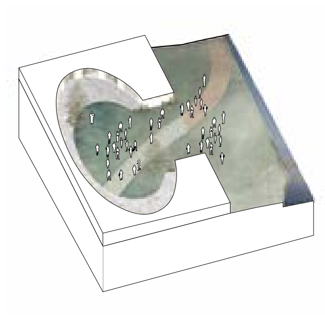

Ill. 103, visualization of arrival to site

COURTYARD PROGRAMMING



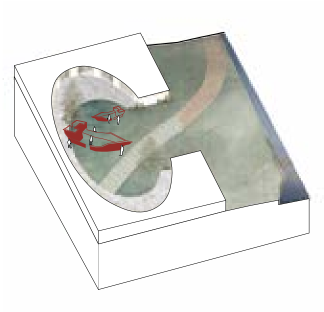
OUTDOOR EXHIBITIONS

Place for temporary outdoor exhibitions, art installations and the museums' thematic exhibitions, where visitors will get the opportunity to explore and engage



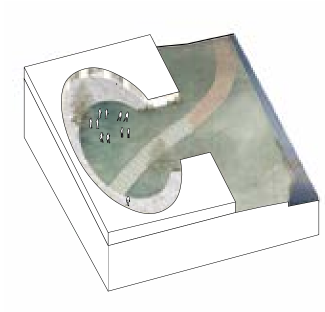
EVENTS

Connecting the courtyard opening to the remaining green area leaves possibilities for utilizing the courtyard space for engaging in urban activities



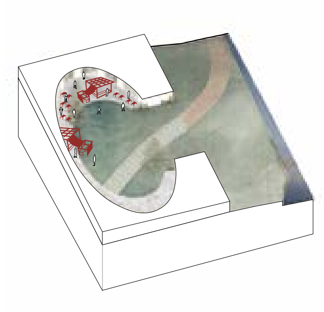
RECONSTRUCTIONAL WORK

The spatial layout is big and flexible enough to include parts of the reconstructed ships that can be easily transported to water and utilized for sailing purposes



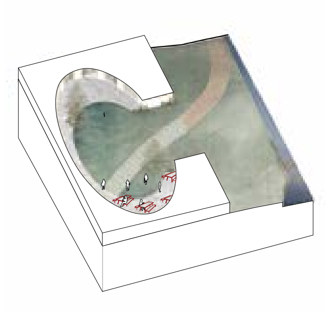
CALM ACTIVITIES

The space is landscaped with two main walkways, and adequate lighting to enhance the viewing experience and scourge outdoor activities.



OUTDOOR WORKSHOP AREA

An outdoor space connected to the workshop area is incorporated to create an interactive and playful area, where visitors can engage and learn about the viking age

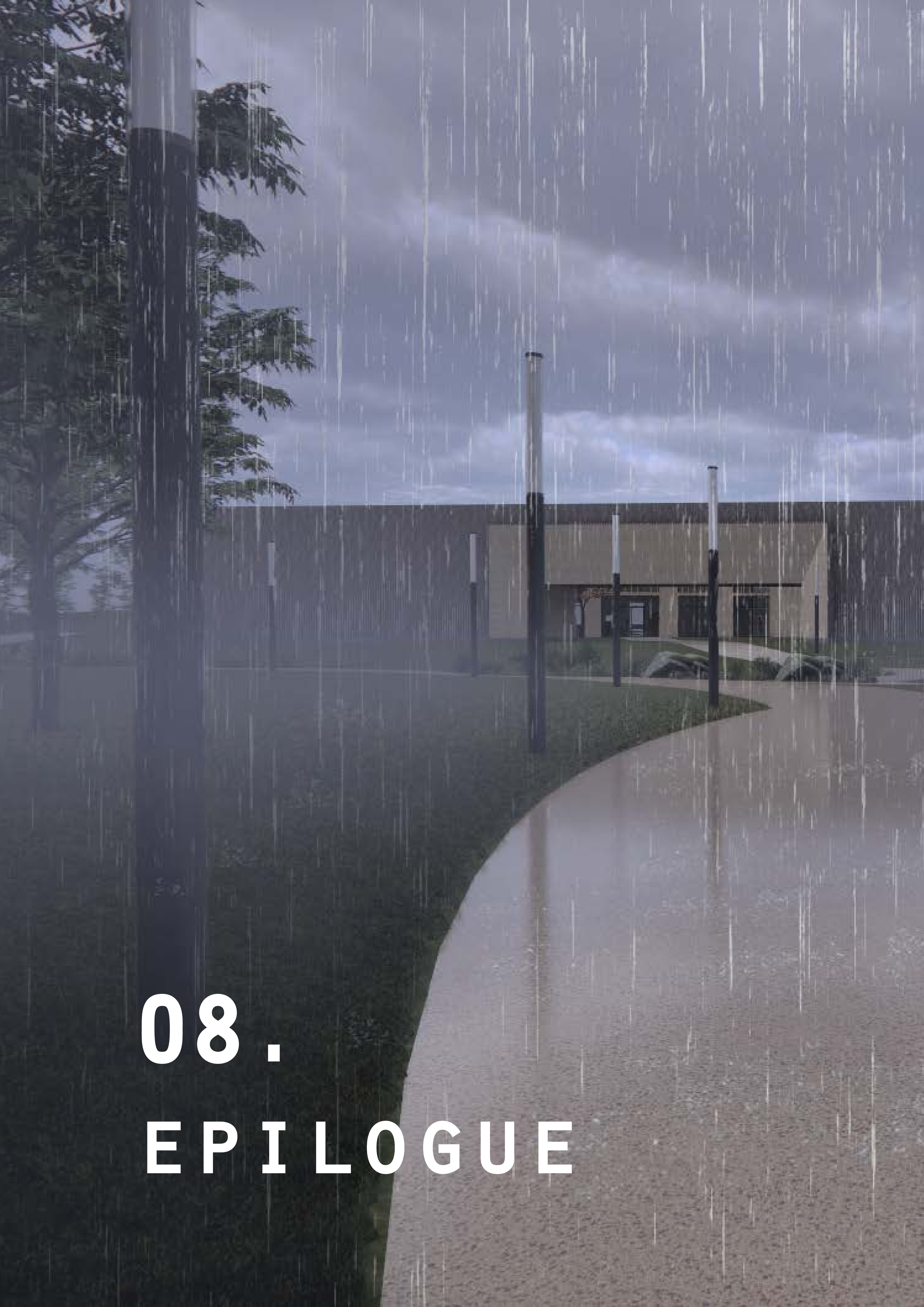


OUTDOOR CAFÉ AREA

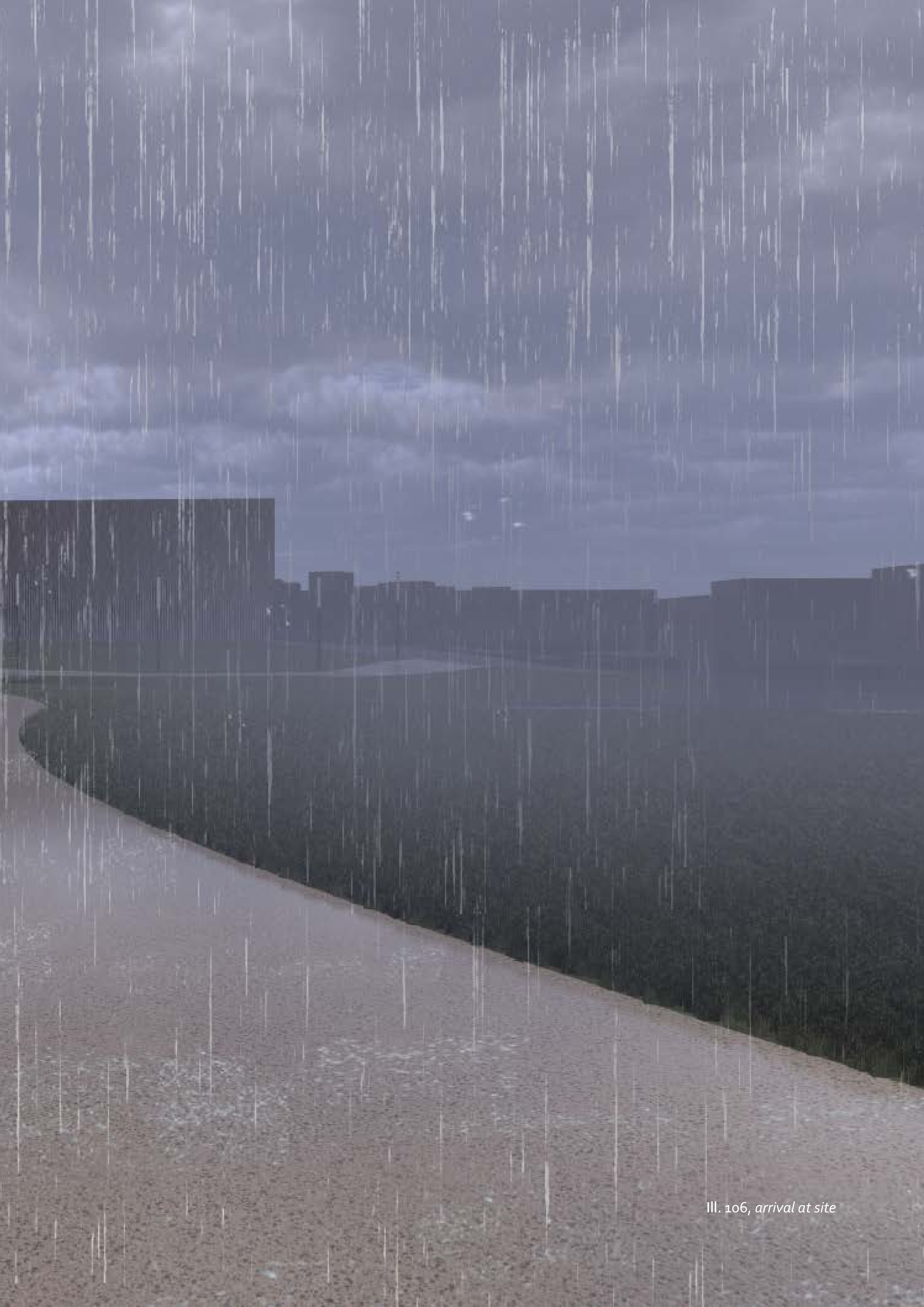
Outdoor seating areas are integrated in the southern part of the courtyard, where visitors can enjoy refreshments, or observe the nearby museum facilities

Ill. 104, courtyard principles

Ill. 105, visualization of courtyard



08.
EPILOGUE



Ill. 106, *arrival at site*

CONCLUSION

Having set out to design a new frame for the Skuldelev ships, the proposal has ended up focusing on the indoor environment as well as the overall architectural expression. Both to pay a symbolic homage to the Viking Age and fit into the nearby context through the sustainable solutions obtained through the usage of wood with the materiality carefully considered regarding their global warming potential to minimize the environmental impact of the design.

Through spatial layout, functions, and materials, special care has been taken to balance the well-being of visitors and the preservation of the five original ships' exhibitions manifested in the clear distinction of the building. The layout for the western part of the new Museum has been designed as one open space being able to display the Viking ships through proper space, incorporating lighting, temperature, and structural calculations to abide the preservation requirements for the ships and allowing visitors to appreciate their craftsmanship, historical impact, and importance.

Placing windows along the north façade and as lines in the roof of the ship hall, ensures adequate levels of illumination hours as well as the desired visual connection to the island where the ceiling concentrates the daylight to the outer limits of the room minimizing the risk of damaging the ships. Furthermore, the ventilation system is conceptually designed meeting the needs for lowered humidity and controlled temperatures levels for the ships. Lowering the ceiling of the hall is carefully designed to diffuse sound rays and improve the quality of the sound, lowering the discomfort for the visitors. By choosing to have wooden walls, the reverberation time is lowered to meet the recommended values for a big hall, achieving a neutral background for the ships as the center of attention. The light, structural system and the ramp stands in contrast to the massive ships, which help accomplish the wished atmosphere.

The ramp allows the visitors to observe and experience the ships from different perspectives and angles enabling close dissemination and a larger impression of their intertwined connection.

In support of the main exhibition, the other part of the new museum presents additional exhibitions where a variety of theme-related exhibits and other interactive exhibits are being placed. Separating the functions in two parts of the museum helps ensure well-organized and easily navigated paths.
To create a variety in atmospheres, these two parts of the new museum have different structural systems, ceiling heights, lighting, and different interior claddings. Furthermore, to minimize the impact on the environment, the CLT timber structural system is utilized in two different principles to create a visually appealing and cohesive structure that relates not only to the landscape nearby but also to Viking history. The wood is also utilized on the facades to harmonize with the island facade expressions creating a visual connection between the facilities.

Implementing the courtyard ensures a connection to the context and the urban space but also helps with opening the compact volume to allow different opportunities for the natural lighting. The courtyard is an essential feature that provides an area for relaxation, artistic engagement, and social interactions.

In addition, the focus on well-being through the indoor environment resulted in placing windows on the first floor and lamella covering partly the second floor, lowering the risk of overheating in summer. Thereby, the requirement for operative temperatures is followed. The big glazing areas on the ground floor are also important to ensure visual indoor comfort and functions as a connection between the outside activities and the inside facilities.
The design combines two different ideas of experience into a mysterious façade keeping the cultural heritage in a safe environment making the visitor experience varying atmospheres each contributing to the exhibition spaces and supports the importance of preserving the five original Viking ships.

REFLECTION

In the beginning of the project various themes were addressed to be the driving forces for the design, however few have been actively utilized during the design phase. Although they have appeared rather sporadic throughout the development of the building some specific aspects such as the human experience, the effect of light, and construction principles to name a few, have not been directly studied in terms of the project. Other aspects such as personas have been presented but not actively utilized for the intended purpose serving as common knowledge rather than actual wishes visitors want to implement.

Regarding the start of the design phase, the process has been gradually focusing on form trying to relate to context and merging the museum complex together, which retrospectively decreased the amount of time to truly focus on optimal solutions regarding structure, ventilation, and illumination both in terms of the museum experience and for the preservation of the ships.

The design phase driving on the form resulted in using technical calculations late in the process which preferably should have been implemented beforehand taking into consideration that the indoor climate in the Viking ship Hall has not been solved entirely leading to a principal solution because of lack of time.

Time became short as the project tries to grasp multiple topics in the span of three months trying to solve the entire project from tectonics, through Life Cycle Assessment, and indoor climate giving multiple topics all affecting the outcome of a project designed with multiple loose ends rather than one specific focus and truly create an integrated solution of architecture and the strict indoor climate requirements.

As a method for aiding the design process it was expressed to use physical models to obtain an understanding of the spatial influence on the site, however due to a more online-based group work this approach was quickly abandoned to clearer communicate ideas and concepts. This led to some disadvantages as the quick modeling and physical impression of scale has been lost leading to a building volume of great proportions as opposed to a more defined, well-justified integration to the context.

This arrangement led to daily meetings to notify of advancement of the individual tasks to give an overview of the evolution of the project. These meetings have resulted in an alternate workflow making quick remarks and evaluation rather difficult to conduct disrupting the workflow when needed. The online environment limited the necessary overview of the project often making it hard to understand what studies are being conducted. On one hand it limited the approach to physical models, but on the other hand it helped to document the design process making it ready to be presented in the report.

As the design evolved with having one volume, the group would have liked to furthermore investigate the meeting between the new museum and the island. This would be to further investigate the pros and cons of having the courtyard to the east from a flow point of view, as the group is happy with the result from the aesthetical perspective. Further investigations for the north facade would as well be prioritized in terms of having two big vertical windows that stand in contrast to the minimal horizontal windows of the other facades. The positive side of these windows are that the desired atmosphere in terms of lighting, for the ship hall, is achieved.

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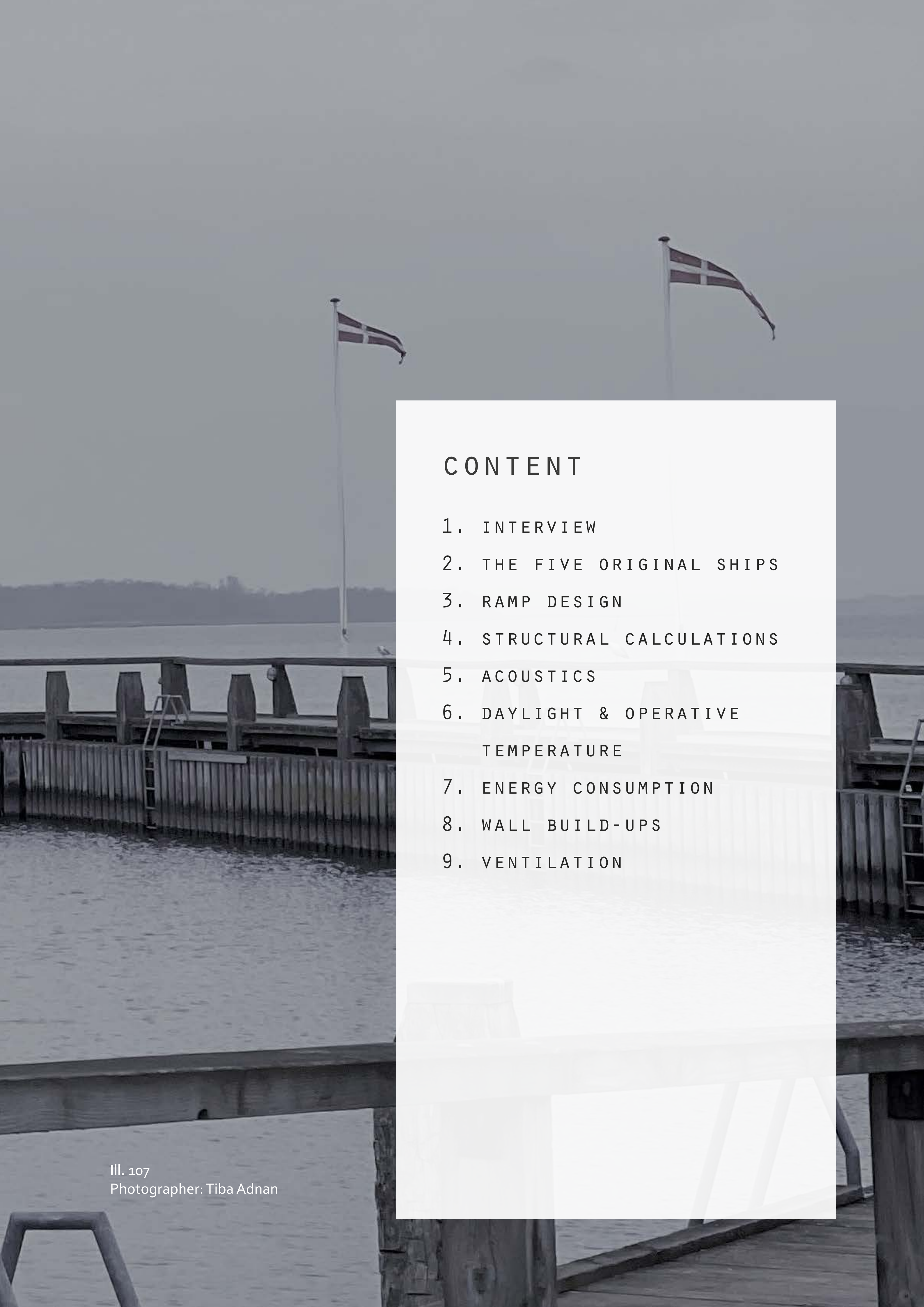
09.

APPENDIX



CONTENT

Ill. 107
Photographer: Tiba Adnan

1. INTERVIEW

WITH PROJECT COORDINATOR OF THE NEW MUSEUM: KRISTOFFER BIRKEBÆK KEJSER

Taler (the interviewer)

Thanks for having us. Holding us this project , we were hoping you could tell us something about the competition? Maybe what you are allowed to share with us? But firstly you can start by introducing yourself.

Taler (Kristoffer Kejser)

My name's Kristoffer Kejser. I'm the project coordinator of the project for this new Viking Ship Museum that will be built...etc. I've been here for three years. Before that I was in the municipality. Of muscularity. And actually last year I was working with the new Viking Ship Museum from the point of view and making different analyses. And it's also going to be in the future. So this very, very close relationship between municipality and museum is, yeah, it's very important if, if we want the new project to succeed.

The new location of the new museum is right next to the existing line... Yeah, which is in the architectural competition. The competitions need to find a very good placement for this new project.

So what was our next question?

Taler (the interviewer)

Now when we know about the placement of the new museum, what happens to the old one ? Do you have any information about what will happen there?

Taler (Kristoffer Kejser)

Yes, the existing museum building is included in the competition. We ask for a transformation of the building to other purposes still within the museum but well the. The challenges as you also know is to secure the ships against the water and the storms and so on. And for many years, the museum has tried to raise money to make a renovation of the building. Yeah, which didn't succeed because fans don't want to donate money for renovation projects. They want new buildings ! Yeah. And then after the Great Storm Board in 2013 where it was really, really bad and and and very close to that the ships were destroyed because of the water the museum made a decision that we can no longer keep the old museum. Ships and then all this about the delisting of the building took place and. And when the delisting was realized in 2018, the plan was to tear down the building and instead build a new museum on the same site, using some of the same values, like seeing the ships with the the the floor and the sky and the landscape as background. But then, quite shortly afterwards, the National Museum concluded that the daylight that the ships get today is way too much. It's destroying the material, so after this news we found out we have to build a new building to ship with. Very little daylight or probably no daylight at all on artificial lights. And then there was that year, it didn't make a lot of sense to build a new museum at the end of the sea with no windows, so it was more attractive to build a new building at the back of the museum and more protective as well. There was certainly another possibility to see if we could actually live with a building where there's a small risk that it will be flooded. If we prepare the building for it maybe. But again it's important to protect the ships and also still use the old building for other purposes. Such as exhibitions, activities and stuff like that.

Taler (The interviewer)

So that means that you want to build a new building ?

Taler (Kristoffer Kejser)

Yeah, Both new and old museums need to sum up the overall functions so no need to move the museums' old functions to the other newer building in. We need a place to actually build the ships and also to work on the ships. But we currently have very little space to do that. We need more space to actually tell the stories about the ships, tell the stories about the Viking age. And we also have the problem that in the summer time we have a lot of activities outdoors. In winter time we only have what is inside the Viking Ship Hall, which makes it very difficult to attract visitors too. So it's important to keep the visitors' experience of the museum in all seasons and especially in the winter time. So that's also one of the reasons we want to build new buildings. We need more facilities for activities during the year round, but also to disseminate the Viking Age and the stories about the ships. So you could say. Take the ships out and put them in a new building and around them. We also make room for more dissemination.

Taler (The interviewer)

So you are thinking when you when you say when you mentioned activities, are you thinking about any particular user group or is it like for all user groups?

Taler (Kristoffer Kejser)

It could be like that could be many many possibilities. It could be a place where we put on some of the boats for winter time where we're going to do repair work so we can disseminate the way we're working with the skills of book building during the winter times. It could also be like we also have this maritime what's called Marine SPA. We are making these investigations in the. Maritime parts of Eastern Denmark whenever we are going, if there's going to be a new bridge or New island in Copenhagen or something. And from there we get a lot of different findings which could also be put in the backing ship hole and actually work. On documentation, the documentation of some of the findings we make out there. So it's I think it's you gotta say it's quite broad. It's from many different types of groups of our guests who could be interested in it but we are very much a practical museum which are. Combining the old findings with all our work at the boat boatyard and and and make these yeah, this more practical, uh dissemination alive in the winter times. That would be one of the important purposes of the new viking ship museum.

Taler (The interviewer)

Yeah. So you know we. Have also talked about the placement of the new viking museum. Do you have a preferable size of the new or but also a new?

Taler (Kristoffer Kejser)

Like we have the numbers we have around it is around 3000 to 3300 square meters for the for both of these buildings together and it might also be a possibility to build it as one building, but the thing right. We have started talking about more buildings because we want to have buildings which fit into the landscape. Yeah it is a very small area. In many ways, very fragile and also a lot of interest, a lot of value. So how can you make a building which still gives us better opportunities for making museums, but still also keeps the connection between the city and the water and and the public can access the area?

Taler (The interviewer)

They're thinking of connecting the new buildings with the existing writing or or is it more going to be that it stands a separate building and then the new ones will be?

Taler (Kristoffer Kejser)

Hmm, yeah, I think it's going to be a separate, separate building. That's what we are aiming for, of course, it would be much easier for us if it was one building which altogether it would be cheaper, it would be easier to to, to deal with. The studies we made in the States here, but it would, it would just be too, yeah, too compact and too massive to fit into the landscape. So we left this out here quite early in the process I guess.

Taler (The interviewer)

Do you have any requirements for the room program?

Taler (Kristoffer Kejser)

We have of course really many requirements for it, but especially in the building for the new exhibition hall for the ships. There are indoor requirements regarding the climate inside, where it has to be very specific about the temperature, about the humidity and and and of course the light, the daylight, the looks and and the UV radiation. So that's a lot of technical stuff that needs to be taken into consideration. We have this competition in 2 phases. The first phase is more open and then the second phase. We take the two or three best projects and work further with them for the second phase.

Taler (The interviewer)

So you have like, you're very focused on the technical part ?

Taler (Kristoffer Kejser)

I think we are. We're very much focused on the overall approach. Plan off of the area, connections and see how the different aspects work together. How do the indoor requirements for the new building work together with the landscape with surroundings? But then we have a lot of different technical specifications, which is very, very necessary according to the indoor climate, according to. Blood protection and these and if they're not solved, then we cannot move on. So if so, it's like you have to make them. That technical specification has to be fulfilled and then on top of it we have different solutions from them which can fulfill our purposes in different ways.

Taler (The interviewer)

Do you feel like you have any preferable materials that you like at least?

Taler (Kristoffer Kejser)

No, actually. We are really curious about what the architects are going to use. I think we have a very big ambition on sustainability. The challenge here is when you have these old wood that the ships are made of. The usual answer of making these fulfilling the criterias for the indoor climate is concrete because wood you cannot use wood inside close to the shift because there's a lot of difference.. Yeah, things come from the wood, at least from the normal way. If you use wood, there might be other solutions to make for wood cladding. And we really hope that we see some new solutions that we didn't imagine before. So, we are very open about which materials, but again. We have to protect the ships, so if the materials cannot, if they cannot prove that they are secure for use in the ship or then, then we'll probably can't can't use it.

Taler (The interviewer)

Are there any specific requirements for the for example humidity or the temperature ?

Taler (Kristoffer Kejser)

Yes, I can send you the technical specifications about the indoor climate.

Taler (The interviewer)

Very nice.That will help a lot. So do you feel like you have the wish for the new project? Maybe you want to attract more user groups like for example children in that sense to the museum.

Taler (Kristoffer Kejser)

Yes exactly, we especially want to do more for the younger children. We already have a lot of youth and young, but what we need is to have small children and especially in winter time, again in the summertime, we have different activities.This also depends on that museum now has less space or too little space to to underline the story is about the Viking gate and the ships. So for the new design we want to put more focused on the stories, more focused on the people, more focused on the cultural historics and about the ships and the Viking Age, which would, yeah, go more for the cultural services.

Taler (The interviewer)

That sounds nice. Right now you have the exhibition in the wake of the Vikings. So this is where it tells more of the story of how you found these ships and how they were a part of building this museum. Is that a story that you want to enhance? Maybe would people prefer to stay in the museum where they have permanent exhibitions?

Taler (Kristoffer Kejser)

Yes, I think at least elements from it could be a part of a permanent exhibit. Because yeah, we we have museum and we have we found the the path but we also have always trying to see how can we fit things into the into the time into the future and and yeah can we make some of these parallels from back in time to the future. And to the. Different crises we're looking at right now. These are also quite wonderful pictures and movies of these.

Taler (The interviewer)

So if the museum is located here and presents the ships in the way you found them, located right here now in, where would you store the rest of boats?

Taler (Kristoffer Kejser)

We hope that we can still fit the boats into the landscape and have a place for them there. I think it's probably not all the ships could be there probably. Maybe there could be some more at the museum island or or we can have another possibility of taking some of the boats? To another to another destination, but, but hopefully they could be at the same area but used in different ways, more active for destination, where today it's not very active destination. We have ships in the winter time.

Taler (The interviewer)

So yeah, maybe doing something more for winter time will be suitable to attract younger people.

Taler (Kristoffer Kejser)

Yeah, yeah, that would be wonderful if we could. Because we have a lot of guests. During summer time. It's hard to fit in more. People in the area and parking lots and things so so. So we hope that most of the growth in visitors could be outside, I mean peak season. This is how it's today.

Taler (The interviewer)

Yeah, we could imagine there's a lot of people here doing different things.

Taler (Kristoffer Kejser)

Yeah. it's around 2000 people that we know of, is it ? I can't remember. We have like 170,000 people visiting in a year as it is now, and yeah, and it is like. Not in the winter time. So in many cases to July, August and start of September it's it's it's it's peaking, yeah.

Taler (The interviewer)

It looks like a very attractive area around the museum.

Taler (Kristoffer Kejser)

Yes, and it's also and and of course this is also the ongoing discussion of the municipality to what this area can be used for? Yeah, taking off the area just for museum purposes and what who had to leave for the public. And this is. This deal with the municipality about today we have this public pathway going straight across the museum island and and in during the area. And we have the idea to the the principle to to split it up like one is having a new walking path just at at the at the seabed where you can get people in the public right out to the floor, and you have another which is more like for bicycling and high speed transport on the on the other side and then. In the middle. We can more like make this area where we can. Have a payment payment so and and we can make this the stories more. Yeah, like it's it's. It's more all together in one story but it is quite split up today in different locations and different settings. And there's, they just send you from the municipality into the hospital. We're discussing these principles in September. I guess it was last year. Yeah, there's a small yeah. Drawing on the principles of someone I can just send you a link to it if you don't have it already. Yeah, about the story. About the public and the.

Taler (The interviewer)

We are thinking about making a 3D model of the entire area, do you have that maybe you know more with the context and stuff like that or do you know where to find?

Taler (Kristoffer Kejser)

Maybe in, in 3D or no? But we don't have any 3D-models

Taler (The interviewer)

It's okay.

Taler (Kristoffer Kejser)

By the way there are some drawings of the existing building or something, then just yeah, we could see what we have. We have at least some of them. Yeah, the original drawings of the construction and so on. So yeah, if you need anything then.

Taler (The interviewer)

That sounds good. thanks. So we had this discussion a few days ago about the problems that may be existing with you right now. You mentioned something about. Of course the indoor environment, but are there any other issues that you find very like?

Taler (Kristoffer Kejser)

Yes, in the existing building, yes. In general, you have a lot of problems because the building was built in the 60s with the yeah, different technology, different knowledge and and is placed right in the water. There's been using a very thin layer of concrete on the construction. The iron inside the constructions is easily affected by the salt where. The salt is making corrosion in the air in the middle of the constructions at the different parts. So the building is kind of falling apart a bit down especially in the Western parts and yeah it makes it. Yeah, a lot of different things. Also with some of the glass, there's some glass mosaics just beneath the roof, which is breaking because the building is moving.

Taler (The interviewer)

So the pressure is like on the windows.

Taler (Kristoffer Kejser)

Yes, we had to put wood to support the big windows because the glass is literally falling down. There was also an incident where there was glass falling down on the ships. And then we have, of course we have very bad access for disabled people because we have these different stairs all over the place. And since it had been listed, to avoid that the new museum should have an elevator .That's also some of the details we are really looking forward to including in the new museum, to actually could have accessibility for all because it's yeah, it's very bad.

Taler (The interviewer)

Yeah, compared to all the modern buildings and like our approach to architecture nowadays and yeah, but of course the old museum is considered too old, very old.

Taler (Kristoffer Kejser)

Yes, it is. But it still has a lot of values. This is kind of our vision, to see how we can have these values kept in the new building which is more modern also for energy consumption.

Taler (The interviewer)

How about the general expression of the new museum, do you have anything maybe for the project you have thought about if it should be more in Viking style or maybe have something more simple ?

Taler (Kristoffer Kejser)

We are trying to make it very clear that we do not want Viking architecture. We want a modern building because, yeah, it's also actually one. So we aim for a new building which fits into the landscape which is sustainable and yeah, so. If they practice some great ways to to use some of the curves or some of the materials from the ships. etc..

Taler (The interviewer)

Well, is there anything else about the project that we have talked about that you think we should be aware of ?

Taler (Kristoffer Kejser)

Well, you could say one of the problems we have today also is the preservation of the five original ships in, yeah. In the building. And then we have the replicas in the harbor and it's very, very difficult to maneuver visitors to understand the connection between. These two paths, and that's the part we also want to have this inner part of the hover just just down here which today is not really very well used and and one of our hopes is that the new building which also could come closer to the harbor would make it easier. Or to make this connection between the original shapes inside and the replicas outside and this. Yeah, this connection between. And then in general, we have very high ambitions for the landscape too because today it's just very flat. And very uninspiring. So, so, so also, it's also one of the things we are asking the architect about. See how can building the landscape work together? How can in, inside and outside be more flexible? Can be, yeah, more inviting to also get out in the landscape and take the dissemination activities. Out in the landscape and maybe during winter time, probably bit more back and push a bit more out in, in the in the. So, so, so all these are different. Yeah, of course. We cannot do it with the room where the ships are inside. But this also has to be something outside you. Also kind of. The solution where you get into the darkness and into the climate and and you can use it much more where you use the landscape and surroundings before you get into the room where the ships are situated. And then of course that we also really don't want to turn the back to the city because we think in some ways existing walls turn this back to the city. So we also see how we can make buildings with no backside, where everything is inviting or and of course a new building with very little. Not very many windows could also invite you to use the roof or integrate paddling into the landscape, or something like that. It could also be very interesting, yeah. So yeah, it's some of the thoughts we've been ourselves and.

Taler (The interviewer)

Yes, thanks. And what about the offices? Do you prefer having them over here as they are right now ? or maybe having them as a part of the new building.

Taler (Kristoffer Kejser)

Well, we have decided to keep the offices here. We would like to have them over there. But again it's it's very expensive square meter. So we just have to of course we have to have a few offices for them. The staff working in the tickets, the store, and yeah, lunch room and so on. But in general. We will keep the offices here and then probably also in the transmittance building. We can have some workshops and some things over there as well.

Taler (The interviewer)

It's a lot of good information. We feel like we have a good startpoint to start this project. So it's a really good input. Thank you for that.

Taler (Kristoffer Kejser)

And then, of course, you also have this, this interesting part of how to get the ships out of the existing building and into the new building because it's really a very complicated task because they spent the 1st 25 years of building this life. Span of assembling the ships inside the hall and the way they've been assembled is that it's not possible to to detect the ships. It would be most easy to. Detach and put it down the boxes and carry it over. We probably have to to move the ships in and as they are and they have to be put into the boxes of with for climate and for local climate and and and how to to move them without making, yeah without. Just trying to figure out what it is. It's really really tough. So somehow we have to, we have to the new building you have to have room for a box like 25 meters long and the. Like 3 meters wide or something which just somehow goes to get into the building and then you have to unwrap.

Taler (The interviewer)

Like instantly we think about having like 3 or 4 volumes because it makes the whole like flexibility and flow easier. Or like so.

Is it something that you consider, or do you prefer like maybe working with one big volume?

Taler (Kristoffer Kejser)

No, I would like to have one big volume for the case of the ships, for the exhibitional ships because we also want the ships to display them as a fleet of ships and so on.

Taler (The interviewer)

OK. We don't need to consider that that's good.

Taler (Kristoffer Kejser)

No, no, no one. One for the shapes and one for the entrance building. That's fine for these two buildings, but no more than that. And it's getting too, too complicated. And then also you can see we also have, yes, the problem about the flooding. We have to also be solved in the landscape and maybe in the buildings or because I think the highest point down here is around 2 meters and we have two. To secure up to I can't remember, I can write you 22 meter and 70. So a possibility is that the building in itself could be, yeah. Resist water for like 48 hours or something. Or you can build something around the buildings, but you cannot build. Filled bikes in the water because it's a natural protected area, so we're not. Yeah, so that's not. A part of this. And so and we also think it's it's it's it's quite interesting to have this landscape which also is designed that it could be flooded at the at the at different times so. Because of the lack of gates, the water level was 1 meter higher than it is today. So this is also one of the stories from the bagging age which is still very, very relevant today. Yeah, about how the coastal line has.

Taler (The interviewer)

If you keep the old museum, then you lose the sight of the water for the new museum. Have you thought anything about that? Because in some ways you're going to lose the view to the north a bit. The new volume will be placed behind the old one in that sense.

Taler (Kristoffer Kejser)

Yes, I think unfortunately it is lost also because of the missing daylight that we have to protect the ships too. So I think we are more thinking about how we can in general create this the same. Atmosphere is in the new hall, of course, with more artificial lights and so on. And then on the other hand, see the possibilities we get in disseminating the ships. And also to make like shows and you can really make more. Yeah, make it a bit more, yeah. What do you say? Yes, it's a more intense experience of the shift because you can use other means of. Making the scenes and then yeah, sitting around them. In the beginning I was thinking maybe you could make this. Did you know this came up in school where you have an old technology where you just with a lens you can take light into a dark building and then you know the lens can display the lights out in the room and say maybe you can just with. With some kind of analog technology you can actually have the view inside the hole, but yeah, it's just it's just a thought, but. I think we just have to find a new way of making the scenery and the atmosphere run ships.

Taler (The interviewer)

So maybe the lighting would be a challenge.

Taler (Kristoffer Kejser)

Yes and then it could affect the indoor comfort for people. Because if you want to attract more Danish guests we need some changes for the atmosphere. These ships have been in the same setting for the last 50 years. But if we haven't seen, we have some kind of live installations or something, you can make themes. And different experiences change every year or half a year or something. So it could also be part of a way of attracting more people to the music.

Taler (The interviewer)

We think we have now all the answers we need for our questions. So that's very nice. So I think we're of course going to go into this and have. A look at it. But regarding the photos of the exhibitions inside and how does that work, can we take some outhouse and use or?

Taler (Kristoffer Kejser)

You're welcome to take photos.

Taler (The interviewer)

Perfect ! Thanks for having us !

Taler (Kristoffer Kejser)

Thank you.

ADDITIONAL NOTES FROM INTERVIEW

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Specific requirements for the indoor climate of the new exhibition hall:

The ships are very fragile in their surface and in their structure, making it necessary that the ships are not exposed to dust particles that will require risky cleaning supplies.

An effective zoning is necessary to avoid influence from the ships' close zones regarding temperature, humidity, dust and so on

Sunlight and radiation is harmful for the ships and must be avoided, meaning precautions to sunlight entering the building must be considered, as well as sun protection and blackouts must be incorporated to control the amount of daylight and secure the indoor climate

The indoor climate must be controllable and adjustable within the narrow boundaries of temperature, humidity, air quality, sunlight and radiation, which applies in both the room of the ships, but also the nearby transition zones

To maintain a stable climate and to reduce energy consumption, the windows must not be openable in the room of the ships

Only moderate fluctuations are allowed in the climate, as larger and more frequent fluctuations over time, can cause damage to the ships and accelerate the decomposition

Specific data:

The nearby zones of the ships must keep a humidity at 45-55% with fluctuations at a maximum of +/- 5% over 24 hours, and must keep a temperature at 18-23 degrees

In every other zone there are no specific requirements for humidity, and the temperature will remain on a comfort level at 20-26 degrees

Ventilation principles and zoning must participate in avoiding dust and sediments attaching to the surfaces of the ships

The lighting must not exceed the maximum of 1500 luxhours within 24 hours (for example 150 lux x 10 hours)

The radiation must be as close to 0 ug/lumen as possible

Moving the ships:

Once the new building is ready, the ships must be transferred from their current location to the new building, which gives a number of conditions with importance to the design and the form of the building

The proposal must include a clear disposition and layout with permanent or temporary openings that makes the move possible

The openings must enable both the ships and their transport boxes to be moved without obstacles, and must have a size of 5,5 x 6,8 x 27 meters (HxBxL)

Design principles for water level and wave wash:

The two new buildings must be projected for a water level at kote +2,53 meters DVR90, which is the predicted water level to occur during a storm surge event with a 250 year return period

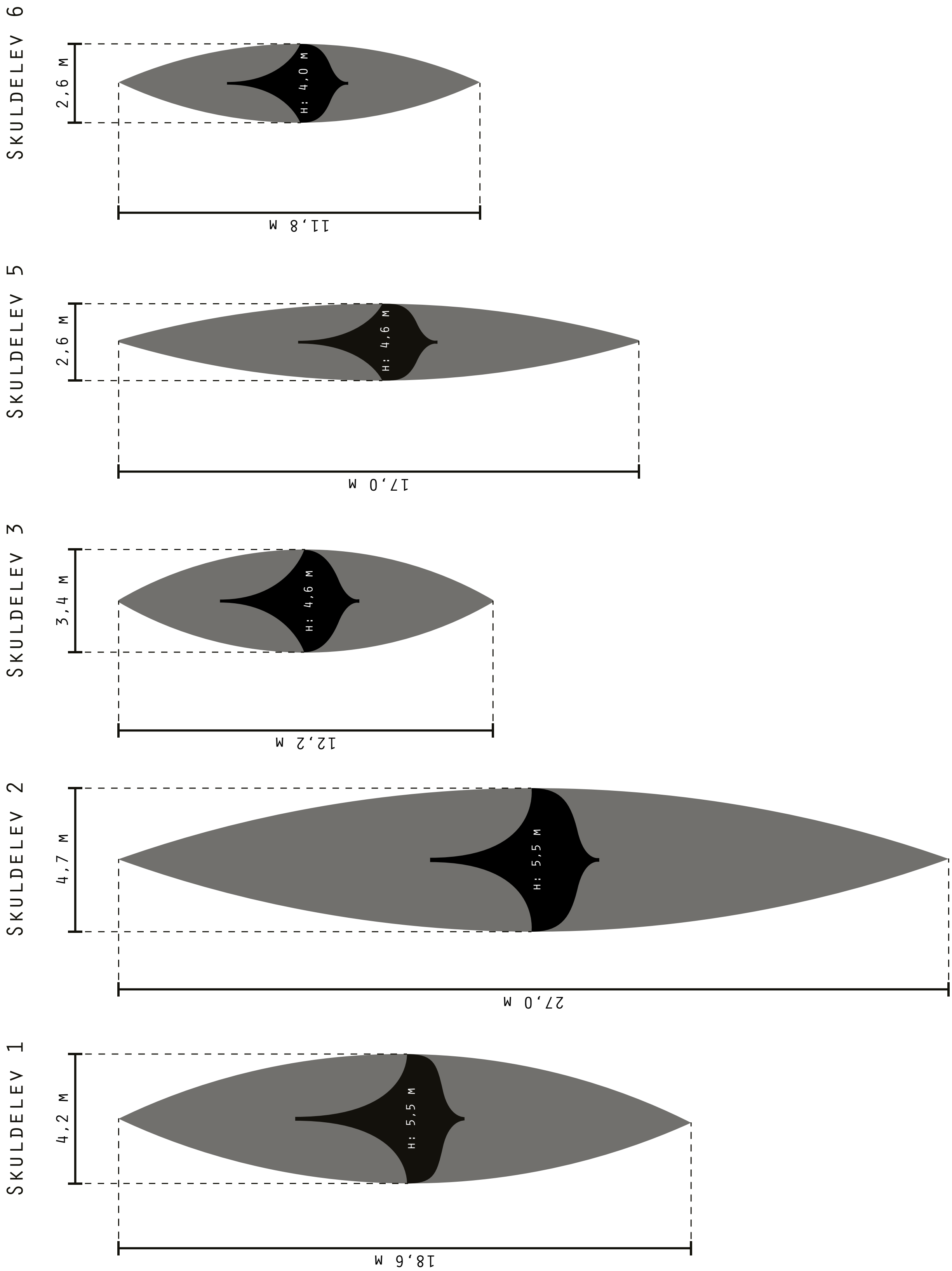
The two buildings must both be projected to ensure further climate securing in the future, which means that they must both ensure the possibility of securing at a higher kote

The wave wash onto the construction must be taken into consideration, meaning both the water impact and the power and energy that the waves applies to the construction and elements in the facade

To reduce the wave wash, different approaches can be made, for example implementing elements in the urban area, but this must be based on the restrictions covered by Kystbeskyttelse, Natura 2000, as special measures would require permission according to the Coastal Protection Act

2. THE FIVE ORIGINAL SHIPS

SIZES & MEASURES



3. RAMP DESIGN

REQUIREMENTS & RESTRICTIONS

Every ramp has been determined to reach the desired height of 3,5 m to the second level, leaving space for room utilization on the first level. Each ramp is equipped with a required platform for every rise of 0,6 m vertically and has been studied to find their rise ratio determining their building regulation compliance. Each ramp is 2 m wide with platforms of 2 x 2 m.

As per using a ramp in the design, it is crucial to be aware of the regulations hereof. A ramp must not exceed a slope of 1:20, rising 0,05 m per meter. Furthermore, a ramp must be equipped with platforms for every 0,6 m rise. As the ramp must be usable for multiple visitors, these platforms should have a length of 3,0 m, while having a similar width of the ramp. This determines the length of the ramp to reach first floor level of 3,5 m through calculation:

Amount of platforms: Height / Height_platform = Amount_platform
3,5 m / 0,6 m ≈ 5

Length of platforms: Amount_platform * Length_platform = Length_Sum
5 * 3,0 m = 15 m

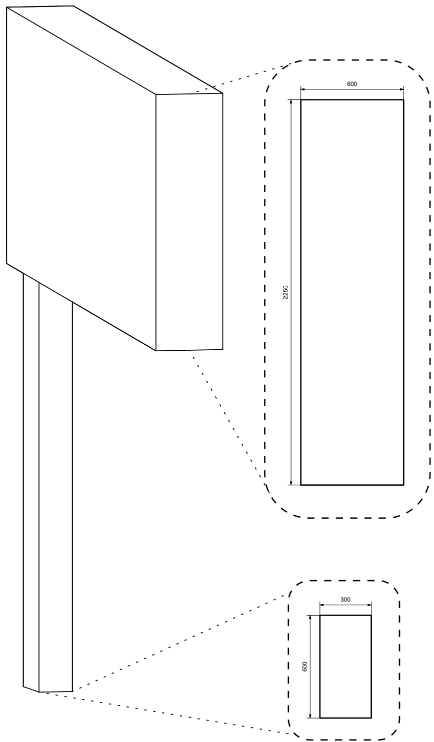
Length of ramp: Height / Height_rise + Length_Sum = Length_Ramp
3,5 / 0,05 m + 15 m = 85 m

The ramp must have railing on both sides. As the ramp has to work both as an experiential tool and as circulation the ramp will have a transparent railing.

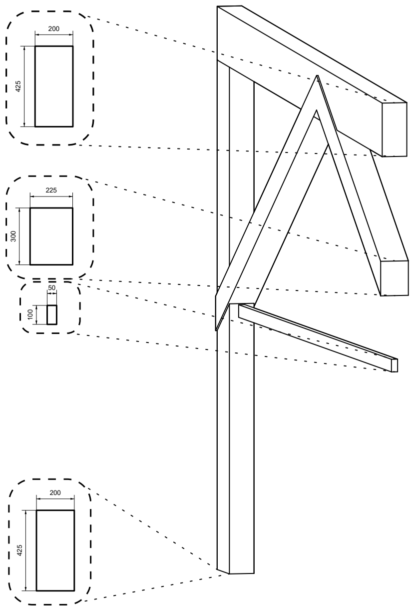
4. STRUCTURAL CALCULATIONS

LOAD-BEARING CONSTRUCTION

SOLID BEAM STRUCTURE					
Room Length	66	m			
Number of Collumns	30	stk			
Collumn DIstance	2,2	m			
Room Width	35	m			
Catchment Area	17,5	m			
LOAD AREA	38,5	m2			
Affecting loads			**Cutting Forces**		
			Horizontal Equilibrium		
Load of roof	6,924207739	kN/m2	R_AH = F_H		
Snow load	0,8	kN/m2	F_H	0	kN
			Vertical Forces (R_AV, R_BV)		
			R_BV = (1/2) * F_V * l		
Breaking state limit	9,509	kN/m2	R_BV	366,0983976	kN
Utility state limit	7,724207739	kN/m2			
			Moment		
			M_max = 1/8 * F_V * l^2		
			M_max	3203,360979	kNm
Beam Calculation					
Height, H	2250	mm	MATERIAL	Gluelam Timber	
Width, W	600	mm	Class	GL30h	
Length, l	35000	mm	Strength, f_m,k	30	MPa
Section Area, A_ef	1350000	mm2	Elasticity Module	13600	MPa
LOAD ON BEAM	9,509049287	kN/m2			
LINEAR LOAD	20,91990843	kN/m			
TENSION STRENGTH, CALCULATED			DEFLECTION		
Load Type	Permanent Load				
k_mod	0,6		INSTANT DEFLECTION		
gamma_M	1,3		Inertial Moment	569531250000	mm4
f_m,d	13,84615385	MPa	u_inst	52,77330212	mm
TENSION STRESS, CALCULATED			**FINAL DEFLECTION**		
M_d	3203360979	Nmm	k_def	0,6	
W_y	506250000	mm3	u_fin	84,43728339	mm
sigma_m,d	6,327626624	MPa	u_fin_allowed	87,5	mm
LOAD-BEARING ABILITY					
			0,9649975244	**< 1**	
0,4569952562	**< 1**				
Column Calculation					
			TOTAL LOAD		
Breaking state limit	45,502	kN/m2	Load Combination	BGT	
Utility state limit	37,71865321	kN/m2	Areal Load	45,50238385	kN/m2
			Point Load	1751,841778	kN
Width, W	300	mm	MATERIAL	Gluelam Timber	
Height, h	600	mm	Class	GL30h	
Length, l	9000	mm	Strength, f_c,0,k	30	MPa
Area, A, (A_ef)	180000	mm2	Elasticity Module	13600	MPa
Inertial Moment	5400000000	mm4			
Inertial Radius	173,2050808	mm	GEOMETRICAL SLENDERNESS		
			lambda_y	51,96152423	
COMPRESSIVE STRENGTH, CALCULATED			lambda_rel,y	0,7768478913	
Load Type	Permanent Load				
k_mod	0,6		Imperfection Factor	0,1	
gamma_M	1,3		k_y	0,8255887177	
			k_c,y	0,9049284049	
f_c,0,d	13,84615385	MPa			
			LOAD-BEARING ABILITY		
COMPRESSIVE STRESS, CALCULATED					
sigma_c,d	9,732454325	MPa	**0,776745956**	**< 1**	



TRUSS STRUCTURE					
Room Length	66	m			
Number of Collumn	15	stk			
Collumn DIstance	4,4	m			
Room Width	35	m			
Catchment Area	17,5	m			
LOAD AREA	77	m2			
Truss Definition					
			Angular Difference	Adjusted Length	
Rect. Length, bottor	35	m	0	35	m
Rect. Length, top	35	m	3	35,04803211	m
Rect. Length, A	2,334272275	m	0	2,334272275	m
Rect. Length, B	0,5	m	0	0,5	m
Number of beams			length		
Top	10		3,504803211	m	
Bottom	10		3,5	m	
Affecting loads			**Cutting Forces**		
			Horizontal Equilibrium		
Load of roof	6,924207739	kN/m2	R_AH = F_H		
Snow load	0,8	kN/m2	F_H	0	kN
			Vertical Forces (R_AV, R_BV)		
			R_BV = (1/2) * F_V * l		
Breaking state limit	9,509049287	kN/m2	R_BV	73,32016225	kN
Utility state limit	7,724207739	kN/m2			
			Moment		
			M_max = 1/8 * F_V * l^2		
Load on beam	9,509049287	kN/m2	M_max	64,24318502	kNm
LOAD DISTRIBUTIONS					
Top Beams					
Knots	11				
			Load (kN/m2)	Load (kN)	
		End Knots	11,40018018	87,90185379	kN
		Knots	11,40018018	175,8037076	kN
Bottom Beams					
Knots	11				
			Load (kN/m2)	Load (kN)	
		End Knot 1		7,403053514	kN
		End Knot 2		7,851348163	kN
		Knots	0,2221810776	3,421588595	kN
Top Beams Calculation			**Bottom Beam Calculation**		
Height, H	425	mm	Width, W	50	mm
Width, W	200	mm	Height, h	100	mm
Length, l	3504,803211	mm	Length, l	7000	mm
Section Area, A_ef	85000	mm2	Area, A, (A_ef)	5000	mm2
MATERIAL	Gluelam Timber				
Class	GL30h		MATERIAL	Gluelam Timber	
Strength, f_m,k	30	MPa	Class	GL30h	
Elasticity Module	13600	MPa	Strength, f_c,0,k	30	MPa
Density	480	kg/m3	Strength, f_t,0,k	24	MPa
			Density	480	kg/m3
LOAD ON BEAM	9,509049287	kN/m2	Elasticity Module	13600	MPa
LINEAR LOAD	41,83981686	kN/m			
			Inertial Moment	4166666,667	mm4
TENSION STRENGTH, CALCULATED			Inertial Radius	28,86751346	mm
Load Type	Permanent Load				
k_mod	0,6		STRENGTH, CALCULATED		
gamma_M	1,3		Load Type	Permanent Load	
			k_mod	0,6	
f_m,d	13,84615385	MPa	gamma_M	1,3	
TENSION STRESS, CALCULATED			f_c,0,d	13,84615385	MPa
M_d	64243185,02	Nmm	f_t,0,d	18,27692308	MPa
W_y	6020833,333	mm3			
sigma_m,d	10,67014838	MPa	STRESS, CALCULATED		
			sigma_c,d	0,6843177189	MPa
LOAD-BEARING ABILITY					
			GEOMETRICAL SLENDERNESS		
0,7706218272	**< 1**		lambda_y	242,4871131	
			lambda_rel,y	3,625290159	
DEFLECTION					
			Imperfection Factor	0,1	
INSTANT DEFLECTION			k_y	7,237628878	
Inertial Moment	1279427083	mm4	k_c,y	0,07406389096	
u_inst	4,724204174	mm	**LOAD-BEARING ABILITY**		
FINAL DEFLECTION			**0,5055314479**	**< 1**	
k_def	0,6				
u_fin	7,558726678	mm			
u_fin_allowed	8,762008027	mm			
0,862670595	**< 1**				



ROD DETERMINATION					
MATERIAL	Gluelam Timber		Rod	Length	Angle (horizontal)
Class	GL30h		1	3,535533906	8,130102354
Density	480	kg/m3	2	3,605750497	166,0893257
Strength, f_m,k	30	MPa	3	3,605750497	13,91067431
Strength, f_t,0,k	24	MPa	4	3,711069613	160,5830442
Strength, f_c,0,k	30	MPa	5	3,711069613	19,41695583
Elasticity Module	13600	MPa	6	3,84861054	155,4252009
			7	3,84861054	24,57479912
Height	300	mm	8	4,015063247	150,6588155
Width	225	mm	9	4,015063247	29,34118447
Area, A_ef	67500	mm	10	4,206997392	146,2992925
Rod	Tension (SAND)	(sigma_t,0,d)/f_t,0,d)	(sigma_c,d)/(k_c*f_c,0,d)		
1	FALSE	-	0,6939986002		
2	TRUE	0,1466064936	-		
3	FALSE	-	0,8421198829		
4	TRUE	0,1508886719	-		
5	FALSE	-	0,6391306912		
6	TRUE	0,1564809593	-		
7	FALSE	-	0,5439006031		
8	TRUE	0,163248773	-		
9	FALSE	-	0,4973725218		
10	TRUE	0,08552631926	-		
Column Calculation					
			TOTAL LOAD		
Breaking state limit	10,475	kN/m2	Load Combination	BGT	
Utility state limit	8,52925227	kN/m2	Areal Load	10,47510272	kN/m2
			Point Load	806,5829097	kN
Width, W	200	mm	MATERIAL	Gluelam Timber	
Height, h	425	mm	Class	GL30h	
Length, l	9000	mm	Strength, f_c,0,k	30	MPa
Area, A, (A_ef)	85000	mm2	Elasticity Module	13600	MPa
Inertial Moment	1279427083	mm4			
Inertial Radius	122,6869322	mm	GEOMETRICAL SLENDERNESS		
			lambda_y	73,35744597	
COMPRESSIVE STRENGTH, CALCULATED			lambda_rel,y	1,096726435	
Load Type	Permanent Load				
k_mod	0,6		Imperfection Factor	0,1	
gamma_M	1,3		k_y	1,141240758	
			k_c,y	0,6864032087	
f_c,0,d	13,84615385	MPa			
			LOAD-BEARING ABILITY		
COMPRESSIVE STRESS, CALCULATED					
sigma_c,d	9,489210703	MPa	**0,9984392197**	**< 1**	

5. ACOUSTICS

REVERBERATION TIME CALCULATIONS

Viking Ship Hall - Study nr. 1

All wood - smooth expression

V [m3]	18450

Equivalent absorption area	Materials	Area S(m^2)	125 Hz α	Sα	250 Hz α	Sα	500 Hz α	Sα	1000 Hz (1kHz) α	Sα	2000 Hz (2kHZ) α	Sα	4000 Hz (4kHz) α	Sα
Floor	Wood parquet on concrete	2050	0,04	82,00	0,04	82	0,07	143,5	0,06	123,00	0,06	123,00	0,07	143,5
Ceiling	wood tongue and groove	1840	0,24	441,6	0,19	349,6	0,14	257,6	0,08	147,20	0,13	239,2	0,1	184
Walls	Playwood paneling over 57 mm airspace	1630	0,28	456,40	0,2	326,00	0,10	163,00	0,1	163,00	0,08	130,40	0,08	130,40
Roof windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,02	4,2
Façade windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,04	8,4
Amount of people and ships		**Amount (n**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**
Visitors		100	0,6	60,00	0,74	74,00	0,88	88	0,96	96,00	0,93	93	0,83	83
The original ships	Wood	180	0,5	90	0,64	115,2	0,76	136,8	0,86	154,80	0,86	154,8	0,76	136,8
Ramp	Vinyl	1	0,5	0,5	0,4	0,4	0,45	0,45	0,45	0,45	0,6	0,6	0,6	0,6
CLT construction	wood	316	0,5	158	0,64	202,24	0,76	240,16	0,86	271,76	0,86	271,76	0,76	240,16
Absorption in air v/50% RF		**Volume** (m^3)	**125 Hz** 4m	mV	**250 Hz** 4m	mV	**500 Hz** 4m	4mV	**1000 Hz (1kHz)** 4m	4mV	**2000 Hz (2kHZ)** 4m	4mV	**4000 Hz (4kHz)** 4m	4mV
		1845	0	0	0	0	0,00	2,95	0,00	7,38	0,01	17,71	0,02	45,02
Total absorption				1364,1		1174,6		1049,3		976,2		1038,9		976,1
Reverberation time	T=(0,16*V)/((Sa*s)+(Sn*A)+(4*m*V)) T=(0,16)*V)/A			2,2		2,5		2,8		3,0		2,8		3,0
			Commerical acoustics	≤1,3		≤1,3		≤1,3		≤1,3		≤1,3		≤1,3
	A: total absorption *V: volume*													

Viking Ship Hall - Study nr. 2

Strong contrast - white plaster

V [m3]	18450

Equivalent absorption area	Materials	Area S(m^2)	125 Hz α	Sα	250 Hz α	Sα	500 Hz α	Sα	1000 Hz (1kHz) α	Sα	2000 Hz (2kHZ) α	Sα	4000 Hz (4kHz) α	Sα
Floor	White plaster	2050	0,01	20,50	0,02	41	0,02	41	0,03	61,50	0,04	82,00	0,05	102,5
Ceiling	wood tongue and groove	1840	0,24	441,6	0,19	349,6	0,14	257,6	0,08	147,20	0,13	239,2	0,1	184
Walls	White plaster	1630	0,01	16,30	0,02	32,6	0,02	32,6	0,03	48,90	0,04	65,20	0,05	81,5
Roof windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,02	4,2
Façade windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,02	4,2
Amount of people and ships		**Amount (n**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**
Visitors		100	0,6	60,00	0,74	74,00	0,88	88	0,96	96,00	0,93	93	0,83	83
The original ships	Wood	180	0,5	90	0,64	115,2	0,76	136,8	0,86	154,80	0,86	154,8	0,76	136,8
Ramp	Vinyl	1	0,5	0,5	0,4	0,4	0,45	0,45	0,45	0,45	0,6	0,6	0,6	0,6
CLT construction	wood	316	0,5	158	0,64	202,24	0,76	240,16	0,86	271,76	0,86	271,76	0,76	240,16
Absorption in air v/50% RF		**Volume** (m^3)	**125 Hz** 4m	mV	**250 Hz** 4m	mV	**500 Hz** 4m	4mV	**1000 Hz (1kHz)** 4m	4mV	**2000 Hz (2kHZ)** 4m	4mV	**4000 Hz (4kHz)** 4m	4mV
		18450	0	0	0	0	0,00	29,52	0,00	73,80	0,01	177,12	0,02	450,18
Total absorption				862,5		840,2		842,9		867,0		1092,1		1287,1
Reverberation time	T=(0,16*V)/((Sa*s)+(Sn*A)+(4*m*V)) T=(0,16)*V)/A			3,4		3,5		3,5		3,4		2,7		2,3
			Commerical acoustics	≤1,3		≤1,3		≤1,3		≤1,3		≤1,3		≤1,3
	A: total absorption *V: volume*													

Viking Ship Hall - Study nr. 3

All wood panels, darker tones

V [m3]	18450

Equivalent absorption area	Materials	Area S(m^2)	125 Hz α	Sα	250 Hz α	Sα	500 Hz α	Sα	1000 Hz (1kHz) α	Sα	2000 Hz (2kHZ) α	Sα	4000 Hz (4kHz) α	Sα
Floor	Wood on joints	2050	0,15	307,50	0,11	225,5	0,1	205	0,07	143,50	0,06	123,00	0,07	143,5
Ceiling	Lamella ceiling	1840	0,40	736,00	1,1	2024,00	2,00	3680,00	2,9	5336,00	2,90	5336,00	2,8	5152,00
Walls	lamella with 50 mm airspace	1630	0,42	684,60	0,36	586,80	0,19	309,70	0,1	163,00	0,08	130,40	0,05	81,50
Roof windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,02	4,2
Façade windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,02	4,2
Amount of people and ships		**Amount (n**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**
Visitors		100	0,6	60,00	0,74	74,00	0,88	88	0,96	96,00	0,93	93	0,83	83
The original ships	Wood	180	0,5	90	0,64	115,2	0,76	136,8	0,86	154,80	0,86	154,8	0,76	136,8
Ramp	Vinyl	1	0,5	0,5	0,4	0,4	0,45	0,45	0,45	0,45	0,6	0,6	0,6	0,6
CLT construction	wood	316	0,5	158	0,64	202,24	0,76	240,16	0,86	271,76	0,86	271,76	0,76	240,16
Absorption in air v/50% RF		**Volume** (m^3)	**125 Hz** 4m	mV	**250 Hz** 4m	mV	**500 Hz** 4m	4mV	**1000 Hz (1kHz)** 4m	4mV	**2000 Hz (2kHZ)** 4m	4mV	**4000 Hz (4kHz)** 4m	4mV
		1845	0	0	0	0	0,00	2,95	0,00	7,38	0,01	17,71	0,02	45,02
Total absorption				2112,2		3253,3		4679,9		6185,5		6135,7		5891,0
Reverberation time	T=(0,16*V)/((Sa*s)+(Sn*A)+(4*m*V)) T=(0,16)*V)/A			1,4		0,9		0,6		0,5		0,5		0,5
			Commerical acoustics	≤1,3		≤1,3		≤1,3		≤1,3		≤1,3		≤1,3
	A: total absorption *V: volume*													

Viking Ship Hall - Study nr. 4

Concrete and wood panels

V [m3]	18450

Equivalent absorption area	Materials	Area	125 Hz		250 Hz		500 Hz		1000 Hz (1kHz)		2000 Hz (2kHZ)		4000 Hz (4kHz)	
		S(m^2)	α	Sα	α	Sα	α	Sα	α	Sα	α	Sα	α	Sα
Floor	Concerete	2050	0,01	20,50	0,02	41	0,06	123	0,06	123,00	0,08	164,00	0,1	205
Ceiling	wood tongue and groove	1840	0,24	441,6	0,19	349,6	0,14	257,6	0,08	147,20	0,13	239,2	0,1	184
Walls	lamella with 50 mm airspace	1630	0,42	684,60	0,36	586,80	0,19	309,70	0,1	163,00	0,08	130,40	0,05	81,50
Roof windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,02	4,2
Façade windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,02	4,2
Amount of people and ships		**Amount (n**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**
Visitors		100	0,6	60,00	0,74	74,00	0,88	88	0,96	96,00	0,93	93	0,83	83
The original ships	Wood	180	0,5	90	0,64	115,2	0,76	136,8	0,86	154,80	0,86	154,8	0,76	136,8
Ramp	Vinyl	1	0,5	0,5	0,4	0,4	0,45	0,45	0,45	0,45	0,6	0,6	0,6	0,6
CLT construction	wood	316	0,5	158	0,64	202,24	0,76	240,16	0,86	271,76	0,86	271,76	0,76	240,16
Absorption in air		**Volume**	**125 Hz**		**250 Hz**		**500 Hz**		**1000 Hz (1kHz)**		**2000 Hz (2kHZ)**		**4000 Hz (4kHz)**	
v/50% RF		(m^3)	4m	mV	4m	mV	4m	4mV	4m	4mV	4m	4mV	4m	4mV
		1845	0	0	0	0	0,00	2,95	0,00	7,38	0,01	17,71	0,02	45,02
Total absorption				1530,8		1394,4		1175,5		976,2		1079,9		984,5
Reverberation time	T=(0,16*V)/((Sa*s)+(Sn*A)+(4*m*V))			1,9		2,1		2,5		3,0		2,7		3,0
	T=(0,16)*V)/A													
			Commerical acoustics	≤1,3		≤1,3		≤1,3		≤1,3		≤1,3		≤1,3
	A: total absorption													
	V: volume													

Viking Ship Hall - Study nr. 5

Different wood types with different textures

V [m3]	18450

Equivalent absorption area	Materials	Area	125 Hz		250 Hz		500 Hz		1000 Hz (1kHz)		2000 Hz (2kHZ)		4000 Hz (4kHz)	
		S(m^2)	α	Sα	α	Sα	α	Sα	α	Sα	α	Sα	α	Sα
Floor	wood flooring on joints	2050	0,17	348,50	0,11	225,5	0,1	205	0,07	143,50	0,06	123,00	0,07	143,5
Ceiling	wood tongue and groove	1840	0,24	441,6	0,19	349,6	0,14	257,6	0,08	147,20	0,13	239,2	0,1	184
Walls	5 mm Playwood, fiberglass with 50 mm air	1643	0,42	690,06	0,36	591,48	0,19	312,17	0,1	164,30	0,08	131,44	0,05	82,15
Roof windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,02	4,2
Façade windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,04	8,4
Amount of people and ships		**Amount (n**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**
Visitors		100	0,6	60,00	0,74	74,00	0,88	88	0,96	96,00	0,93	93	0,83	83
The original ships	Wood	180	0,5	90	0,64	115,2	0,76	136,8	0,86	154,80	0,86	154,8	0,76	136,8
Ramp	Vinyl	1	0,5	0,5	0,4	0,4	0,45	0,45	0,45	0,45	0,6	0,6	0,6	0,6
CLT construction	wood	316	0,5	158	0,64	202,24	0,76	240,16	0,86	271,76	0,86	271,76	0,76	240,16
Absorption in air		**Volume**	**125 Hz**		**250 Hz**		**500 Hz**		**1000 Hz (1kHz)**		**2000 Hz (2kHZ)**		**4000 Hz (4kHz)**	
v/50% RF		(m^3)	4m	mV	4m	mV	4m	4mV	4m	4mV	4m	4mV	4m	4mV
		1845	0	0	0	0	0,00	2,95	0,00	7,38	0,01	17,71	0,02	45,02
Total absorption				1864,3		1583,6		1259,9		998,0		1039,9		927,8
Reverberation time	T=(0,16*V)/((Sa*s)+(Sn*A)+(4*m*V))			1,6		1,9		2,3		3,0		2,8		3,2
	T=(0,16)*V)/A													
			Commerical acoustics	≤1,3		≤1,3		≤1,3		≤1,3		≤1,3		≤1,3
	A: total absorption													
	V: volume													

Viking Ship Hall - Study nr. 6

All concrete - neutral bakground

V [m3]	19475

Equivalent absorption area	Materials	Area	125 Hz		250 Hz		500 Hz		1000 Hz (1kHz)		2000 Hz (2kHZ)		4000 Hz (4kHz)	
		S(m^2)	α	Sα	α	Sα	α	Sα	α	Sα	α	Sα	α	Sα
Floor	Concrete	2050	0,01	20,50	0,02	41	0,06	123	0,06	123,00	0,08	164,00	0,1	205
Ceiling	wood tongue and panels	1840	0,38	699,2	0,45	828	0,85	1564	0,90	1656,00	0,9	1656	0,9	1656
Walls	Concrete	1643	0,01	16,43	0,02	32,86	0,06	98,58	0,06	98,58	0,08	131,44	0,1	164,3
Roof windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,02	4,2
Façade windows	Glass	210	0,18	37,80	0,06	12,60	0,04	8,40	0,03	6,30	0,02	4,2	0,02	4,2
Amount of people and ships		**Amount (n**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**	**α**	**αn**
Visitors		100	0,6	60,00	0,74	74,00	0,88	88	0,96	96,00	0,93	93	0,83	83
The original ships	Wood	180	0,5	90	0,64	115,2	0,76	136,8	0,86	154,80	0,86	154,8	0,76	136,8
Ramp	Vinyl	1	0,5	0,5	0,4	0,4	0,45	0,45	0,45	0,45	0,6	0,6	0,6	0,6
CLT construction	wood	316	0,5	158	0,64	202,24	0,76	240,16	0,86	271,76	0,86	271,76	0,76	240,16
Absorption in air		**Volume**	**125 Hz**		**250 Hz**		**500 Hz**		**1000 Hz (1kHz)**		**2000 Hz (2kHZ)**		**4000 Hz (4kHz)**	
v/50% RF		(m^3)	4m	mV	4m	mV	4m	4mV	4m	4mV	4m	4mV	4m	4mV
		1845	0	0	0	0	0,00	2,95	0,00	7,38	0,01	17,71	0,02	45,02
Total absorption				1120,2		1318,9		2270,7		2420,6		2497,7		2539,3
Reverberation time	T=(0,16*V)/((Sa*s)+(Sn*A)+(4*m*V))			2,8		2,4		1,4		1,3		1,2		1,2
	T=(0,16)*V)/A													
			Commerical acoustics	≤1,3		≤1,3		≤1,3		≤1,3		≤1,3		≤1,3
	A: total absorption													
	V: volume													

6. DAYLIGHT & OPERATIVE TEMPERATURE

ADDITIONAL OVERHEATING HOURS

	Top(0 - TZ Viking Ship Hall)°C	Top(1 - TZ Arch. Exhib.)°C	Top(1 - TZ History of Findings)°C	Top(1 - TZ Kiosk)°C	Top(1 - TZ Lobby)°C	Top(1 - TZ Toilets)°C	Top(1 - TZ Video Media)°C	Top(2 - TZ Climb Aboard)°C	Top(2 - TZ Ship Evolution)°C	Top(2 - TZ Viking History)°C	Top(A - TZ Break Room)°C	Top(A - TZ Drawing Office)°C	Top(A - TZ Offices)°C	Top(A - TZ Workspace)°C
HOURS ABOVE 26														
Original 100% glazing	0	13	6	150	312	0	107	31	365	711	5	16	8	0
100% glazing w lamellas	0	11	5	54	66	0	92	25	133	196	5	10	6	0
75% glazing - no facing North	0	13	6	112	249	0	104	30	334	552	5	12	9	0
75% glazing - Evenly	0	13	6	104	164	0	100	28	231	397	5	10	8	0
60% glazing	0	12	6	75	110	0	94	26	172	267	5	10	8	0
60% glazing w. lamellas	0	9	2	31	20	0	86	22	69	97	3	6	5	0
HOURS ABOVE 27														
Original 100% glazing	0	1	0	45	145	0	36	7	199	447	0	3	3	0
100% glazing w lamellas	0	0	0	20	22	0	32	7	52	106	0	2	2	0
75% glazing - no facing North	0	1	0	33	115	0	35	7	178	339	0	3	3	0
75% glazing - Evenly	0	1	0	31	63	0	35	7	117	226	0	3	3	0
60% glazing	0	0	0	26	33	0	34	7	79	144	0	2	2	0
60% glazing w. lamellas	0	0	0	9	5	0	32	6	25	38	0	0	0	0

7. ENERGY CONSUMPTION

BE18 RESULTS

Nøgletal, kWh/m² år

Renoveringsklasse 2

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
95,5	0,0	95,5
Samlet energibehov		35,2

Renoveringsklasse 1

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
71,7	0,0	71,7
Samlet energibehov		35,2

Energiramme BR 2018

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
41,2	0,0	41,2
Samlet energibehov		35,2

Energiramme lavenergi

Uden tillæg	Tillæg for særlige betingelser	Samlet energiramme
33,0	0,0	33,0
Samlet energibehov		35,2

Bidrag til energibehovet

Varme	17,2
El til bygningsdrift	10,7
Overtemp. i rum	0,3

Netto behov

Rumopvarmning	13,7
Varmt brugsvand	13,6
Køling	0,0

Udvalgte elbehov

Belysning	9,1
Opvarmning af rum	0,0
Opvarmning af vbv	13,7
Varmepumpe	0,0
Ventilatorer	1,0
Pumper	0,2
Køling	0,0
Totalt elforbrug	35,0

Varmetab fra installationer

Rumopvarmning	3,5
Varmt brugsvand	0,5

Ydelse fra særlige kilder

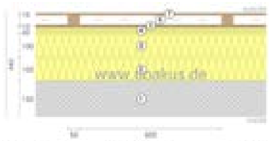
Solvarme	0,0
Varmepumpe	0,0
Solceller	24,1
Vindmøller	0,0

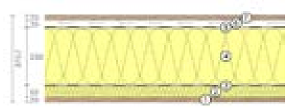
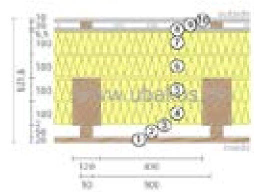
8. WALL BUILD-UPS

INVESTIGATIONS THROUGH UBAKUS

Different walls and roof construction and insulation types were investigated through Ubakus software (Ubakus.de, n.d.), to ensure the thermal protection of the construction. These investigations helped ensure the air tightness for the overall construction, to ensure among other lower energy consumption and better indoor environment.

Underneath are some of the relevant investigations :

 U-VALUE = 0,161 Thermal capacity inside: 345 kJ/m2K	**Wall 1.1** 1. Concrete 2. H2 Feeling Wood insulation 3. H2 Feeling Wood insulation 4. Cork 5. OSB-board 6. Rear Ventilated level 7. Concrete board	150 mm 100 mm 100 mm 40 mm 10 mm 40 mm 10 mm
 U-VALUE = 0,166 Thermal capacity inside: 224 kJ/m2K	**Wall 1.2** 1. Concrete 2. H2 Feeling Wood insulation 3. H2 Feeling Wood insulation 4. Cork 5. OSB-board 6. Rear Ventilated level 7. Oak planks	150 mm 100 mm 100 mm 30 mm 10 mm 40 mm 10 mm
 U-VALUE = 0,125 Thermal capacity inside: 344 kJ/m2K	**Wall 1.3** 1. Concrete Reinforced (2%) 2. Best wood FLEX 50 3. Best wood FLEX 50 4. Breather Membrane 5. Rear Ventilated level 6. Oak planks	100 mm 240 mm 60 mm 40 mm 10 mm

 U-VALUE = 0,108 Thermal capacity inside: 45 kJ/m2K	**Wall 2.1** 1. Oak planks 2. Best wood FLEX 50 3. Vapor Retarder 4. Best wood FLEX 50 + Str. Timber 5. Best wood FLEX 50 6. Breather Membrane 7. Rear Ventilated level 8. Concrete board	12 mm 50 mm 240 mm 100 mm 30 mm 10 mm
 U-VALUE = 0,108 Thermal capacity inside: 45 kJ/m2K	**Wall 2.2** 1. Oak planks 2. Best wood FLEX 50 3. Vapor Retarder 4. Best wood FLEX 50 + Con. Timber 5. Best wood FLEX 50 6. Breather Membrane 7. Rear Ventilated level 8. Oak planks	12 mm 50 mm 240 mm 100 mm 30 mm 10 mm
 U-VALUE = 0,13 Thermal capacity inside: 25 kJ/m2K	**Mineral wool Insulation** 1.Oak 2.Mineral wool 3.Foil, PE 4.Mineral wool 5.Breather membrane sd=0,05m 6.Rear ventilated level 7.Oak	20 mm 50 mm 250 mm 5 mm 30 mm 20 mm
 U-VALUE = 0,11 Thermal capacity inside: 67 kJ/m2K	**Roof** 1 Oak 2 Stationary air 3. Vapour barrier 4-7 H2 Feeling Wood 8 Gypsum board 9 Rear ventilated level 10 Gypsum plaster	 20 mm 50 mm 2 mm 400 mm 9,5 mm 30 mm 10 mm

9. VENTILATION

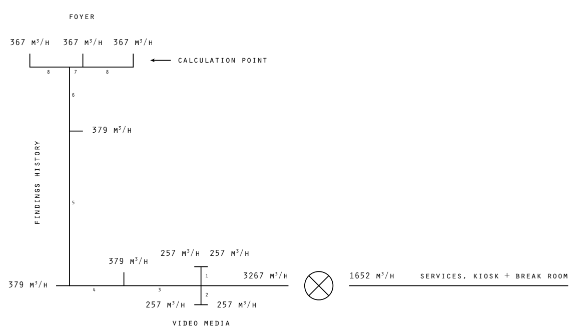
CHANNEL DIMENSIONING

Calculations on two different paths have been made, to ensure that the ventilation channels can fit into the suspended ceiling as well as the shafts running from the second floor. The first calculation is on the path going from the aggregate and towards the foyer, as this path runs through two medium-ventilated rooms. The size of the channels supplying the foyer have been calculated to 250 mm, while the channels running through the first two rooms have been calculated to 500 mm, making them fit into the xxx mm suspended ceiling.

The second calculation is on the path going from the aggregate and up towards the Ship Evolution exhibition. Here it was important to see if the channel running from the first floor and up to the second floor would fit into the integrated shaft. As seen in the results, the channel running vertically has been calculated to 500 mm, making it fit easily into the 1300 mm shaft. The distribution channel going to the Ship Evolution exhibition have been calculated to 500 mm as well, with the size of the channel farthest away calculated to 250 mm, making these also fit into the suspended ceiling.

FIRST FLOOR

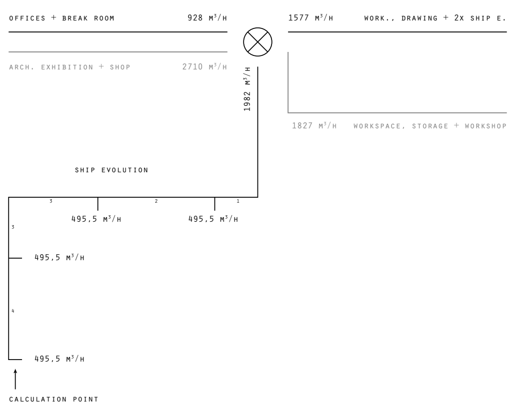
CRITICAL PATH



Dimensioning - first floor				
Channel number	qv (m3/h)	vmax (m/s)	Min. channel size (mm)	Standard channel size
			d > kvrod((4*qv)/(3,14*vmax))	
Main channel	4918,63	9	439,7589435	500
Main/dist. channel to Video Media	3266,742857	6	438,9305115	500
Distribution channel:				
1 - Video Media	2752,457143	4	493,4511987	500
2 - Video Media	2752,457143	4	493,4511987	500
3 - Findings H.	2238,171429	4	444,9698643	500
4 - Findings H.	1859,314286	4	405,5648693	500
5 - Findings H.	1480,457143	4	361,8943855	400
6 - Foyer	1101,6	4	312,1733962	315
7 - Foyer	734,4	4	254,8885107	315
8 - Foyer	367,2	4	180,2333943	200
Connection channel - Video M.	257,1428571	3	174,1568362	200
Connection channel - Findings H.	378,8571429	3	211,3932101	250
Connection channel - Foyer	367,2	3	208,1155975	250
Total qv in chosen zone				
		Armatures	qv pr. armature	
Video Media	1028,571429	4	257,1428571	
Findings History	1136,571429	3	378,8571429	
Foyer	1101,6	3	367,2	
Services, etc..	1651,89			

SECOND FLOOR

CRITICAL PATH



Dimensioning - second floor				
Channel number	qv (m3/h)	vmax (m/s)	Min. channel size (mm)	Standard channel size
			d > kvrod((4*qv)/(3,14*vmax))	
Main channel at aggregate	9023,66	9	595,6401433	630
Main channel vertical	4486,11	9	419,9792495	500
Distribution channel Ship E.	1982	4	418,7316136	500
Distribution channel:				
1	1982	4	418,7316136	500
2	1486,5	4	362,6322147	400
3	991	4	296,0879634	315
4	495,5	4	209,3658068	250
Connection channel	495,5	3	241,7548098	250
Total qv in chosen zone				
	qv (total)	Armatures	qv pr. armature	
Arch. Exhib. + Shop	2710,29			
Office + break	927,77			
Workspace + D. office	1576,63			
Workspace, st. + workshop	1827,26			
Ship Evolution x2	990,8571429	2	495,4285714	
Ship Evolution x4	1981,714286	4	495,4285714	